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THE WESTERN RANGE

LETTER

FROM

THE SECRETARY OF AGRICULTURE

TRANSMITTING

IN RESPONSE TO SENATE RESOLUTION No. 289
A REPORT ON THE WESTERN RANGE—A GREAT BUT
NEGLECTED NATURAL RESOURCE

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THE WESTERN RANGE

LETTER

FROM

THE SECRETARY OF AGRICULTURE

TRANSMITTING

IN RESPONSE TO SENATE RESOLUTION No. 289
A REPORT ON THE WESTERN RANGE—A SHORT SUPPLY
OF IRRIGATED NATURAL RESOURCES

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LETTERS OF TRANSMITTAL

DEPARTMENT OF AGRICULTURE,
Washington, April 28, 1936.

The PRESIDENT OF THE UNITED STATES SENATE.

SIR: In compliance with the request in Senate Resolution 289 (74th Cong., 2d sess.), introduced by Senator Norris, I have the honor to submit herewith a report on the range problem of the western United States prepared by the Forest Service of this Department.

The resolution reads:

> Whereas large parts of the western range have been subject to unrestricted use since settlement and are commonly believed to be more or less seriously depleted; and
>
> Whereas the range resource constitutes one of the major sources of wealth to the Nation; and
>
> Whereas the Department of Agriculture has through many years of research and of administration of the national forests accumulated a large amount of information on the original and present condition of the range resource, the factors which have led to the present condition, and the social and economic importance of the range and its conservation to the West and to the entire United States: Therefore be it
>
> *Resolved*, That the Secretary of Agriculture be, and hereby is, requested to transmit to the Senate at his earliest convenience a report incorporating this information, together with recommendations as to constructive measures.

In transmitting this report I shall resist the temptation, despite my great personal interest in the range question, to comment at length on its findings and recommendations, and instead merely emphasize three of the most important phases of the discussion.

1. The first of these is the astonishing degree to which the western range resource has been neglected, despite its magnitude and importance.

One indication of this neglect is the lack of public knowledge. The general public knows less of the range resource, and as a result has been and is less concerned about its condition and conservation than of any other of our important natural resources. This is true in spite of the fact that the range occupies about two-fifths of the total land area of the United States and three-fourths of that of the range country; that the range territory produces about 75 percent of the national output of wool and mohair, and in pounds about 55 percent of the sheep and lambs, and nearly one-third of the cattle and calves. In fact, this report represents the first attempt, although much of the range has been grazed for 50 years at least, to make an all-inclusive survey of the range resource, its original and present condition, the causes and effects of changes, the social and economic function which it does and should render to the West and to the Nation, and, finally, to outline practical solutions for at least the more important problems.

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The entire history of public-land disposal under both Federal and State laws reflects this neglect. These laws have with few exceptions been framed and administered without regard to range conditions and requirements. The result is an ownership pattern so complex that satisfactory handling of the range is seriously handicapped. In this pattern is interminglied an enormous area that all of the available information indicates is submarginal for private ownership.

Further evidence of neglect is failure to regulate the use of range lands in such a way as to maintain the resource. This failure has been so general under all classes of ownership that in contrast examples of good management are decidedly conspicuous. The result is serious and practically universal range and soil depletion, which already has gone far toward the creation of a permanent desert over enormous areas. An even more serious result has been an appalling waste of the human resource. And three-fourths of the range area is still on the down grade.

The commonly accepted theory that private ownership in itself is enough of an incentive to insure the satisfactory handling of range lands has proved to be true only in the case of exceptional ranches.

State range lands have been leased without provision for the management of the resource or its perpetuation. Federal holdings are scattered among many bureaus in several departments. The national forests, which afford an example of large-scale range conservation, are administered by the Department of Agriculture. The grazing districts, which are only now being placed under administration after a half century or more of neglect, and the public domain, which is still subject to unrestricted use, fall under the Department of the Interior. These three classes of land make up the bulk of Federal holdings.

Neglect is further shown by the meager scale of research by both the Federal and State Governments. A reasonable program of research might have prevented many serious mistakes and maladjustments. Extension to carry research findings in better range practices to private owners has been practically nonexistent.

2. The second phase of the situation to which I wish to call attention is the fundamental character both of the range resource and of its use.

They have to do with land; with the production on that land of forage crops, with the utilization of the crops in livestock and, in a lesser degree, wildlife production; with the management of land and its forage cover to obtain watershed protection and the services needed primarily by agriculture for irrigation. Effectiveness in all of these things depends upon the biological and agricultural sciences. In short, they are a part, and in the West one of the most important parts, of agriculture.

Furthermore, through the free play of economic forces, range livestock production—once almost wholly an independent pastoral enterprise—and cropland agriculture have become closely integrated, inseparable parts of the agricultural structure of the West. Except for specialty farms, a high percentage of the hundreds of thousands of western farm or ranch units represent widely varying combinations of range and crop agriculture. More than one-third of the feed for range livestock now comes from croplands or irrigated pastures. Problems of one part have become problems of both. Major maladjustments in either—of which there are far too many—now inevitably

affect the other. No comprehensive program can be prepared for either which does not take the other definitely into account.

3. The third phase of the range situation to which I wish to call attention is a limited number of remedial measures of outstanding importance among the many that are required. The range problem as a whole has been allowed to drift for so long that its difficulties have been accentuated. It has become exceedingly broad and complex, beginning with the basic soil resource at the one extreme, and extending through a wide range of overlapping interrelated problems to human welfare at the other. No single measure offers hope of more than a partial solution.

One of the most important of the measures required is to place all range lands under management that will stop depletion and restore and thereafter maintain the resource in perpetuity, while at the same time permitting its use. This will involve many difficult operations such, for example, as drastic reductions of stock on overgrazed ranges. It will involve various forms of use such as livestock grazing, watershed services, wildlife production, etc., which should be so correlated as to obtain the maximum private and public benefits.

A second line of action involves the return to public ownership of lands so low in productivity, or so seriously devastated, or requiring such large expenditures to protect high public values, that private owners can hold them only at a loss. Closely related are a far-reaching series of adjustments in size of ownership units to make both private and public ownership feasible and effective, each in its proper sphere.

A third line of action is to put jurisdiction over publicly owned range lands on a sound basis. Unquestionably the only plan which can be defended is to concentrate responsibility for the administration of Federal lands in a single department to avoid unnecessary duplications, excessive expenditures, and fundamental differences in policies, and to obtain the highest efficiency in administration and the maximum of service to users. Since the administration of the range resource and its use is agriculture, and since the administration of federally owned ranges can and should be used as an affirmative means in the rehabilitation of western agriculture, the grazing districts and the public domain should be transferred to the Department of Agriculture.

Furthermore, the concentration of jurisdiction over federally owned range lands is a vitally important step toward the concentration in a single department of the still more inclusive functions, including aid and services to private owners of range lands, which should be exercised by the Federal Government on the entire range problem. Such a concentration is a fundamental principle of good organization if the Federal Government is to redeem its full responsibility in the restoration and care of this much-neglected resource.

The States have similar jurisdictional problems which demand attention.

A fourth measure which should be emphasized is the wide scope of research necessary to put range use for all purposes on a sound footing. Closely related is extension, which will carry the information obtained to the private owner and help him constructively in its application.

With these and other recommendations of the Forest Service, I am in general accord, and I hope that in carrying them out there need not be too serious a delay, since further delay will merely serve to accentuate difficulties and increase costs.

The solution of the range problem can be made an important contribution to the conservation of our natural resources. It can be made an important contribution to the rehabilitation of western agriculture. Finally, and most important, it can be made an important contribution to social and economic security and human welfare. Public neglect is partly responsible for the aggravated character of the range problem, and this makes all the more urgent and necessary public action toward its solution.

Respectfully,

H. A. WALLACE, *Secretary.*

UNITED STATES DEPARTMENT OF AGRICULTURE,
FOREST SERVICE,
Washington, April 28, 1936.

The SECRETARY OF AGRICULTURE.

DEAR MR. SECRETARY: I am transmitting herewith the report requested in Senate Resolution 289. This incorporates information obtained by many years of research on the range and watershed problems, by special surveys which have been under way for several years, and by 30 years' administration of the national forests. It includes the pertinent information now available in the Forest Service and that which could be obtained from other Federal and State agencies. It necessarily has the limitations inherent in the first attempt to treat the range resource as a whole, but it is believed that its findings are essentially sound.

One of the primary reasons for the neglect, and hence the serious depletion of the range resource and a series of major maladjustments in land use, has been a division of responsibility among public agencies. No one Federal agency has been responsible for an all-inclusive, affirmative handling of the entire range problem. A similar situation obtains for every western State in which the range is an important factor.

If the Federal Government is to redeem its responsibilities, one of the first and most important needs is, therefore, the concentration of responsibility in a single Federal department. This should include responsibility for whatever additional and feasible action is required to put privately owned range lands in a satisfactory status. Such concentration affords the only effective way to stop the depletion of ranges under way for 50 years, and to start them on the upgrade. Furthermore, such concentration affords the only effective means to integrate range use soundly with the other forms of western agriculture of which it is an essential part. Since the problem is wholly agricultural, concentration must be in the Department of Agriculture.

To redeem their obligations, the States must face and meet similar problems of jurisdiction and responsibility.

Sincerely yours,

F. A. SILCOX,
Chief, Forest Service.

HIGH LIGHTS

1. The range area of 728 million acres is nearly 40 percent of the total land area of the continental United States; more than 99 percent is available for livestock grazing.

2. About half the range area, or 376 million acres, is in private ownership. One-third, or 239 million acres, is Federal range, divided among national forests, grazing districts, public domain, and other withdrawals and reservations.

3. Forage depletion for the entire range area averages more than half; the result of a few decades of livestock grazing.

4. Range depletion on the public domain and grazing districts averages 67 percent, on private, Indian, and State and county lands about half, and on national forests 30 percent.

5. Three-fourths of the entire range area has declined during the last 30 years, and only 16 percent has improved.

6. During the same period 95 percent of the public domain and grazing districts has gone downgrade and only 2 percent has improved. For other forms of ownership and control corresponding figures are: Private lands 85 and 10, State and county lands 88 and 7, Indian lands 75 and 10, national forests 5 and 77.

7. Only about 95 million acres of the entire range area is in reasonably satisfactory condition. Nearly half of the national forest range and 12 percent of private ownership falls in this category. The reasonably satisfactory areas in other ownerships are inconsequential. Probably not much over 5 percent of the entire range area is in a thoroughly satisfactory condition.

8. An outstanding cause of range depletion has been excessive stocking. Some 17.3 million animal units are now grazed on ranges which it is estimated can carry only 10.8 million. The removal of the surplus is the most effective way to stop depletion and start the range on the upgrade.

9. About seven-tenths, or 523 million acres, of the range area is still subject to practically unrestricted grazing.

10. Precipitation in the range country averages less than one-third that of the Middle West and East. One to 4 drought years out of 10 characterize practically all of the range area. The failure to recognize in stocking the wide and direct fluctuation of forage production with precipitation has been one primary cause of depletion.

11. Among financial handicaps to the range livestock producer, possibly the most serious, is the marketing differential, mainly freight, which for Idaho is nearly $8.50 for an 1,100-pound steer in the Chicago market as compared with Illinois.

12. The one best answer to this and other financial handicaps is cheap range feed, which costs only one-fifth to one-tenth as much as hay or other supplemental feed. But serious depletion of range feed has been practically universal, and heavy supplemental feeding has been necessary.

13. Unsuitable land laws and policies have made the range a bewildering mosaic of different kinds of ownerships and of uneconomic units, which together constitute a serious obstacle to range management and profitable livestock production.

14. Range livestock production was once almost wholly pastoral. Thirty-five percent of the feed for western livestock is now supplemental feeds raised on croplands or irrigated pastures—a threefold increase in 45 years. Except for highly specialized crop farming, mostly on irrigated land, western agriculture is now primarily an integration of range livestock grazing and crop farming.

15. Excluding irrigation improvements, the 1930 census values farm lands and buildings, privately owned range lands, and farm and range livestock, etc., at nearly 12.9 billion dollars.

16. Most spectacular among the maladjustments of range-land use has been the attempt to use more than 50 million acres for dry-land farming. About half, ruined for forage production for years to come, has already been abandoned for cultivation, much of it even before going to patent.

17. A more serious but much less spectacular maladjustment has been the private acquisition of many million acres, either submarginal for private ownership as shown by high tax delinquency and relief rolls, abandonment, etc., or having high public values for watershed protection which private owners cannot maintain, or both.

18. Four-fifths of the 232 million acres which yield 85 percent of the water of the major western streams is range land, and low precipitation makes water the limiting factor in nearly all western development.

19. No less than 589 million acres of range land is eroding more or less seriously, reducing soil productivity and impairing watershed services. Three-fifths of this area is adding to the silt load of major western streams.

20. It will probably require more than 50 years of management to restore the depleted range sufficiently to carry even the 17.3 million livestock units now grazed, and probably an additional 50 years to restore it to the nearest possible approach to its original grazing capacity of 22.5 million units.

21. Action of greatest immediate urgency and importance is to—

Stop soil and forage depletion, and start both on the upgrade;

Reduce excessive stocking, place all range lands under management, and restore cheap range feed;

Rectify land ownership and use maladjustments, and obtain a sound distribution of ownership between private and public agencies;

Build up economic private and public units;

Balance and integrate crop and range use;

Correlate the livestock, watershed, forest, wildlife, and recreation forms of range-land uses and services;

Obtain a recognition of the responsibility of stewardship by private owners;

Minimize or remove various financial handicaps of stock producers;

Reconcile range conservation and the financial needs of State institutions;

Solve the tax delinquency problem;

Place public lands under the supervision of agricultural agencies as a step toward unification of public responsibility for the entire range problem. Provide on such lands for a sound distribution of grazing privileges, and prevent the establishment of prescriptive rights;

Obtain and apply the information necessary for the conservation and wise use of the range resource;

Prevent human wastage and insure social and economic security.

ACKNOWLEDGMENT

The preparation of this report has largely been a group effort in which a large number of Forest Service employees have participated. Authorship credited under the various titles only partially indicates the contribution made by these authors, who for the most part have also given a large amount of time and effort to the technical review and constructive criticism of sections other than their own.

The following employees whose names do not appear as authors contributed in such ways as the compilation of data and the preparation of material for the report, or in the critical review of manuscripts, or in an advisory capacity:

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A still larger group at the western forest and range experiment stations, regional offices, and on the national forests has over a period of several years collected the large volume of data which has constituted the main basis for the report.

In addition, a considerable number of Government units, both within and without the Department of Agriculture, have cooperated generously in supplying needed information; among these, acknowledgment is due especially to the Agricultural Adjustment Administration, the Bureau of Agricultural Economics, the Bureau of Biological Survey, the Farm Credit Administration, the Rural Resettlement Administration, the Weather Bureau, and the Bureau of the Census. The ready cooperation of the State agricultural experiment stations in a number of the Western States was also of great assistance.

THE WESTERN RANGE
A GREAT BUT NEGLECTED NATURAL RESOURCE

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I. THE MAJOR RANGE PROBLEMS AND THEIR SOLUTION

A RÉSUMÉ

By Earle H. Clapp, Associate Chief, Forest Service

The western range has never been fully and clearly recognized as one of our great natural resources along with forests, soil, wildlife, coal, oil, iron, and other minerals.

It is not surprising, therefore, that the intrinsic value and importance of the range resource to the West and to the entire country has been seriously underestimated or entirely overlooked. Neither is it surprising that the general public, many conservationists, and even many western stockmen have no real appreciation of the extent to which the range has been neglected and abused, what the consequences have been, and how these consequences have already affected and will in the future continue to affect human welfare.

Outside of the range country the general public and even many conservationists have gained much of what they know from fiction. They have a hazy, distorted picture of the glamour of the cattle country, of something far removed, unique, and picturesque which they recognize as having colored all western thought and life.

The western stockman has been too close and too much a part of all that has happened fully to grasp results, trends, and causes. The changes in the resource, ordinarily deterioration, have often been too insidious and too obscure to divert attention from what seemed to be the immediate and compelling problems of livelihood under strenuous competition which all too often in the early days became open warfare. If he has known and cared, he has often been the victim of circumstances over which, regardless of how he struggled, he had little control. Or he has coupled his recognition with an incorrigible optimism which counted on plentiful rains in the season to come, or a turn in the market to make everything right in his livestock business and also with the range itself.

Under such circumstances only the inspired leadership which has stirred the public to action on some other resources could have been effective, and such leadership has been conspicuously absent.

Piecemeal attacks on the range problem have been made in the past, but this report has been prepared in the belief that only a comprehensive attack on the entire range problem will suffice. Many conditions, forces, and problems are common to the entire western range country. Only through consideration of the whole is it possible to obtain a background and a grasp which will permit sound and lasting remedial action.[1]

[1] The report is based on a large amount of information already available in the Forest Service, together with that which could be obtained readily from State, Federal, and other agencies, and, where time permitted, by special surveys. Where exact information was not available the best approximations possible under the circumstances have been made. While great accuracy cannot be claimed for these it is believed that the findings are substantially correct.

Furthermore, such consideration must begin with the forage and soil which constitute the range resource itself, take into account their original and present condition, and how they have been and should be used. It should extend into the now closely related crop agriculture and devote at least passing notice to dependent or closely related services and activities. It must, however, have human beings and their permanent welfare as its chief concern and end objective.

Obviously no attempt could be made to cover all American agriculture of which western range and crop lands are a part. As the broader problems of American agriculture are worked out, the solutions will undoubtedly reflect into and modify in greater or less degree the conclusions reached in this survey.

The western range is largely open and unfenced, with control of stock by herding; where fenced, relatively large units are enclosed.

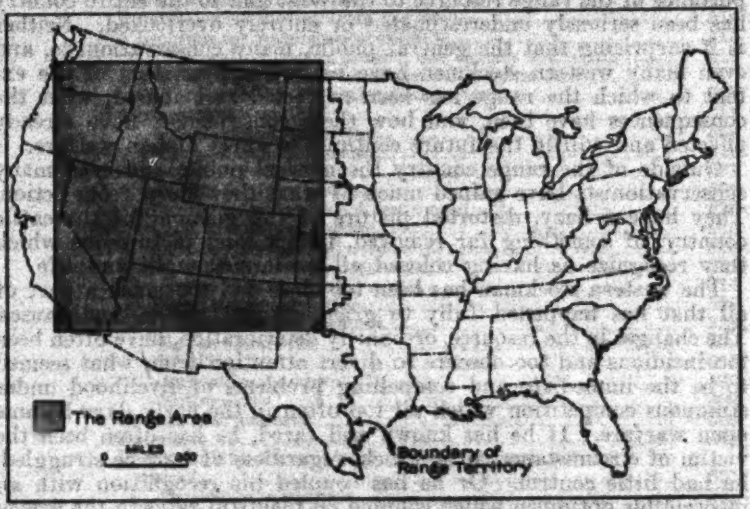


FIGURE 1.—THE RANGE AREA.

The 728 million-acre range area discussed in this report, roughly three-fourths of the land area west of an irregular line extending south through the Dakotas to Mexico and nearly 40 percent of the total land area of the United States, is an indication of the magnitude of the range problem.

It supports with few exceptions only native grasses and other forage plants, is never fertilized or cultivated, and can in the main be restored and maintained only through control of grazing. It consists almost exclusively of lands which, because of relatively meager precipitation or other adverse climatic conditions, or rough topography, or the lack of water for irrigation, cannot successfully be used for any other form of agriculture.

In contrast, the improved pastures of the East and Middle West receive an abundant precipitation, are ordinarily fenced, utilize introduced forage species, follow cultivation for other crops, are often fertilized to increase productivity, and are renewed following deterioration.

The range area covered in this report lies to the west of an irregular north and south line which cuts through the Dakotas, Nebraska, Kansas, Oklahoma, and Texas (fig. 1). The range area aggregates some 728 million acres out of a total land area of 975 million acres. Discussions of the southern and Alaskan ranges are included in the appendix.

The Forest Service is charged with the responsibility for the administration of some 88 million acres of grazable land within the western national forests, of which 94 percent is available for livestock. The national forest ranges are a much more important link in the western range problem than their acreage alone indicates. The impact upon their administration of a group of increasingly serious problems growing out of other range lands in the public domain, in the grazing districts now being formed under the provisions of the Taylor Grazing Act, and in private and in State or other public ownerships, as well as problems in the closely related crop agriculture, has forced the survey which has resulted in this report. Such action has been essential in order to safeguard the fundamental conservation principles which underlie national forest administration and even the integrity of the national forests themselves.

MAJOR FINDINGS

There is perhaps no darker chapter nor greater tragedy in the history of land occupancy and use in the United States than the story of the western range. First it was "the Great American Desert", a vast and trackless waste, a barrier to the gold fields. Unexpectedly and almost overnight it became the potential source of great wealth from livestock grazing. And therein lies the key to the story. All of the major findings which constitute the first part of this discussion have their origin in the effort to capitalize this wealth and convert it to human use.

Serious Range Depletion Practically Universal

The major finding of this report—at once the most obvious and obscure—is range depletion so nearly universal under all conditions of climate, topography, and ownership that the exceptions serve only to prove the rule.

The existing range area has been depleted no less than 52 percent from its virgin condition, using depletion in the sense of reduction in grazing capacity for domestic livestock. Practically this means that a range once capable of supporting 22.5 million animal units[2] can now carry only 10.8 million.

On nearly 55 percent of the entire range area, forage values have been reduced by more than half.

[2] 1 animal unit as used in the report is 1 cow, horse, or mule, or 5 sheep, goats, or swine.

Of the four classes used in evaluating the degree of depletion, material (26–50 percent) and severe (51–75 percent) are most extensive, as shown by fig. 2 and table 3, each covering more than one-third of the total range area. Extreme (76–100 percent) covers a little more than 15 percent, and moderate (0–25 percent) somewhat less.

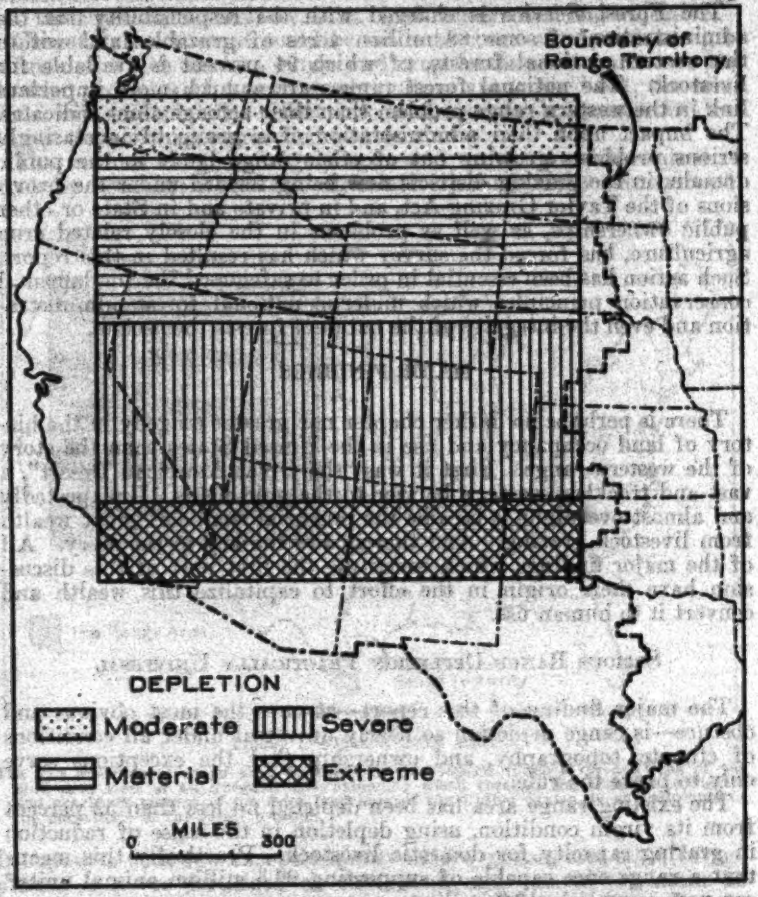


FIGURE 2.—RANGE DEPLETION CLASSES.

Of the depletion classes, material (26–50 percent) and severe (51–75 percent) cover more than seven-tenths of the entire range area. Nearly 120 million acres is in the extreme (76–100 percent) depletion class, and of the 95 million acres in the moderate (0–25 percent) depletion class probably not more than half is in a thoroughly satisfactory condition.

The depletion consists of the disappearance largely or altogether from many parts of the range of such valuable forage plants as the bluebunch wheatgrass, the giant wild-rye, ricegrass, dropseed, sacaton, and California oatgrass. It consists of the replacement of palatable and nutritious plants such as prairie beardgrass and sand-

grass by the unpalatable sand sagebrush and yucca, wild-rye by greasewood, winterfat by shadscale and rabbitbrush. It consists also of the replacement of perennial grasses by much less nutritious annual grasses and weeds. It consists of the invasion of foreign plants, such as the worthless star thistle in California, the nearly worthless Russian thistle now found everywhere, the poisonous Klamath weed, and only a few of limited value, such as cheatgrass for

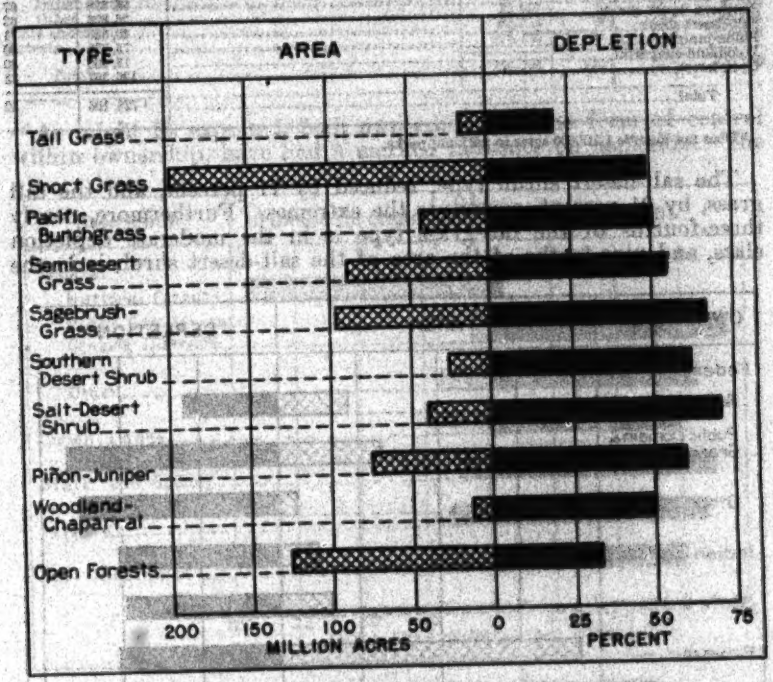


FIGURE 3.—AREA AND DEPLETION OF THE RANGE TYPES.

All range types except two are depleted by half or more. Of the two, tall grass is small in area and reflects especially favorable conditions, and the open forest benefits from a large area under national forest management.

only a few weeks each year, and the alfileria of southern Arizona and California, for a few weeks in wet years.

Still further, depletion consists of marked reduction in density of the better forage plants, with the perennial gramas and fescues as an example. The ordinarily desirable thickening of forests by reproduction and the expansion of brush areas has to some extent also reduced the space for forage plants.

What is true of the range as a whole is also true of the 10 broad types (figs. 25, 30, and 34) into which it has been divided for the purposes of this report, as shown in table 1 and figure 3.

TABLE 1.—*Area of range types and forage depletion*

Type	Area	Depletion
	1,000 acres	Percent
Tall grass	18,513	21
Short grass	120,000	49
Pacific bunchgrass	45,854	31
Semidesert grass	89,270	55
Sagebrush grass	96,838	47
Southern desert shrub	94,888	33
Salt-desert shrub	49,888	71
Piñon-juniper	75,728	49
Woodland-chaparral	17,488	39
Open forest	128,887	34
Total	[1] 726,198	33

[1] Does not include 1,217,000 acres in national parks.

The salt-desert shrub type, reduced by 71 percent, and the tall grass, by 21 percent, constitute the extremes. Furthermore, nearly three-fourths of the tall-grass type is in the moderate depletion class, and nine-tenths of the area of the salt-desert shrub is in the

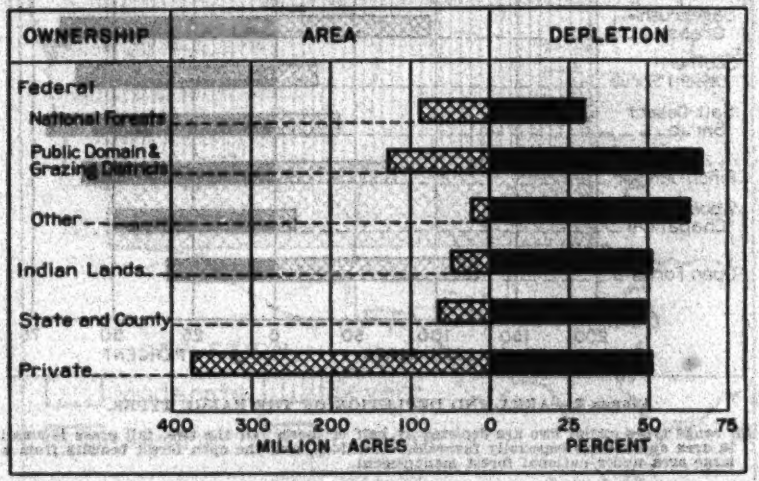


FIGURE 4.—AREA AND DEPLETION BY OWNERSHIPS.

Ranges of all ownerships and forms of control except the national forests have been depleted by half or more. The national forests 30 years ago were probably in even worse condition than the public domain then was because of the comparative abundance of water on the national forests and of the general shortage of summer range.

severe- and extreme-depletion classes. The salt-desert shrub, sagebrush grass, southern-desert shrub, and piñon-juniper ranges now rate about a third of the virgin range.

The reductions in productivity are all the more staggering because of the magnitude of the areas involved.

Ownership, first nearly all Federal, has become more than half private (table 2 and fig. 4).

TABLE 2.—*Range areas and depletion by ownerships*

Ownership or control	Range area		Depletion	Area available for range use
	1,000 acres	Percent	Percent	1,000 acres
Federal:				
National forests	87,054	12	30	62,038
Public domain, grazing districts	127,723	17	67	127,723
Other	48,801	7	51	48,801
Indian lands	22,097	3	69	21,809
State and county	48,516	9	49	46,064
Private	275,948	52	51	275,949
Total	728,199	100	52	730,950

As might be expected, both ownership, and the form of control within ownership, have had a marked influence on depletion. The

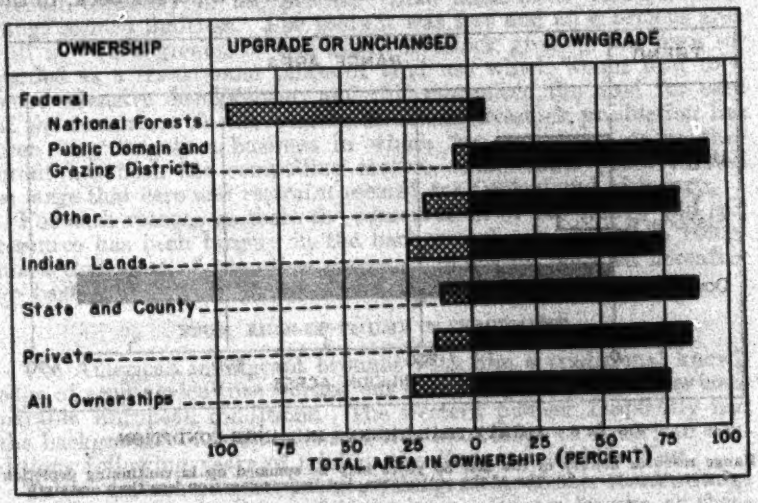


FIGURE 5.—DEPLETION TRENDS OF THE LAST 30 YEARS.

The contrast between the national forests and other forms of ownership or control is in essence a contrast between an attempt at range conservation and practically unrestricted use.

Federal public domain, a no man's land without management prior to the creation of the grazing districts, is in the worst condition, with depletion of 67 percent. Very surprisingly, fee-simple private ownership has been so little of an incentive to the preservation of the range resource that depletion stands at 51 percent. Indian, State, and county holdings have fared no better than private lands. National-forest ranges make the best showing, but despite 30 years' management are still 30 percent below virgin conditions.

Whether range conditions are on the up or down grade may be even more significant than the extent of present depletion. Here also the public domain has the blackest record, with nearly 95 percent of the total area depreciating during the last 30 years and only 2 percent improving (fig. 5). Over three-fourths of the national-

forest range has improved during the same period and only 5 percent has declined. For all other ownerships, largely private lands, from 75 to 88 percent have declined and 7 to 10 percent improved in value. Of all classes of ownership and forms of control only the national forests show any appreciable gain in range conditions.

In a nutshell, the white man's toll of the western range for 50 years, or for less than 100 at the outside, is reduced grazing capacity of more than half. Still further, 76 percent of the entire range has declined appreciably during the last 30 years and only 16 percent has improved (fig. 6).

The virgin range was characterized by wide differences in its vegetation because of marked climatic, soil, topographic, and other variations to be expected in an area of such size. The vegetation ranged all the way from the dense sod of the tall-grass prairies with grass under the most favorable conditions as high as a horse's back, to the

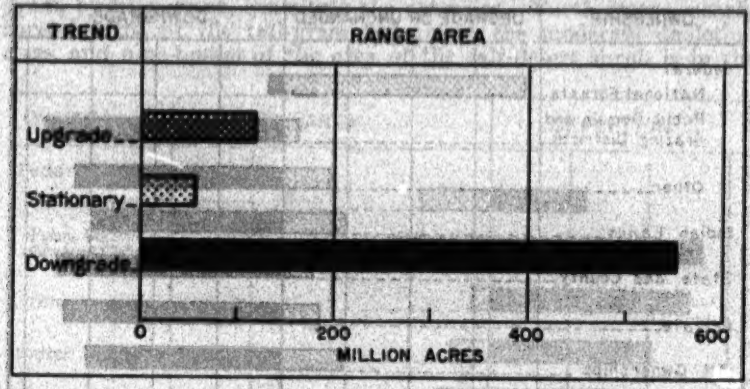


FIGURE 6.—THIRTY-YEAR TRENDS IN RANGE CONDITION.

Range resource history of the last 30 years may be summed up in continuing depletion of more than three-fourths of the entire area, but improvement on less than one-fifth.

low, sparse, scattered clumps of the southern desert shrub. But nearly all ranges produced an abundance of palatable and nutritious plants suitable for pasturage, many of which held their values in curing on the stem.

Before white settlement, the range was used only by game, the great numbers of which are attested by the reports of all the early explorers. Despite these numbers and climatic cycles, and drought periods which were undoubtedly as severe as any of recent years, the range did maintain itself, except for natural variation and for localized and temporary overgrazing, and would have continued to do so if the white man had not upset its natural and fairly stable equilibrium. Truly, man has shown less wisdom and vision in the use of the range resource than did uncontrolled nature. His greatest achievement seems to have been the removal of the natural checks and balances which had maintained the virgin range over thousands of years.

Depletion Resulted from a Few Outstanding Causes

FROM THE TRADITIONAL AMERICAN ATTITUDE

A second major finding is a clarification of the causes of the deterioration and destruction of the range. Outstanding among the causes has been the traditional American attitude toward all natural resources. The exuberance of the American spirit has manifested itself, among other ways, in the lavish use of all the great natural resources with which the United States has been so richly endowed. The philosophy of inexhaustibility and its corollary that no provision need be made for either wise use or perpetuation has been almost universal, and as a result all have been wasted or destroyed with all the resourcefulness and ingenuity of a virile people. Other peoples have destroyed their natural resources but none have shown greater efficiency in the process. Like most other resources, the range seemed limitless. For years it was free and an enormous area still is. To a greater or less extent livestock grazing was once regarded as a transitional phase of land use which would lead to a more intensive development, and this minimized the need for care of the resource. To the western stockman livestock production has been very largely a business in which for one reason or another profit has been the compelling motive. Immediate profit loomed so large that care and restraint seemed far-fetched and visionary.

For such reasons as these the conservation of the forage and soil resource has been largely in the background. It should be recognized that most of the other causes of depletion outlined hereafter go back fundamentally to this traditional attitude.

FROM RULE-OF-THUMB MANAGEMENT

The American immigrant brought with him a traditional knowledge of crop agriculture worked out over many centuries under comparable European conditions. The western pioneer frequently had the background of adaptations of this knowledge to American conditions following years of trial in the East and Middle West.

To the western pioneer, however, the grazing of the western range was an entirely new form of agriculture. Its use by two or three generations of stockmen has afforded far too short a time to develop satisfactory management by large-scale trial and error. The complex biological relationships between plants themselves, between plants, climate, and soils, and between forage and grazing animals were beyond the ken of the range user.

Despite this, however, the resourceful and self-reliant stockman felt absolute confidence in his own ability to meet all requirements, and he neither asked for nor, except in a minor degree, received the benefits of research into range-management problems, the only other means of acquiring the necessary information. Research in consequence has been meager, has among Federal agencies been concentrated largely in three bureaus of the Department of Agriculture, has at the State agricultural experiment stations dealt largely with animal husbandry and range economics, and has in general lagged far behind requirements.

In the complex problem which we are more and more recognizing range use to be, and without the benefits of technical knowledge, the stockman has inevitably gone seriously wrong.

Lacking a sound basis for judging grazing capacity he has overstocked the range almost from the start. How else explain the depletion of the range as a whole by more than half? Climate is the only other possible explanation, and there is more evidence that the western climate has not changed than that it has. Furthermore, there are many specific examples of well-managed ranges on which forage conditions have improved, while adjacent overstocked ranges with identical climate have deteriorated.

After taking into account supplemental feeds and irrigated pastures, which supported 17 percent of the range livestock in 1900 and 38 percent in 1935, the number on range lands reached peaks of approximately 19.9 and 20.7 million animal units in 1900 and 1920, respectively. Since 1920 there has been a declining tendency, with a sharp drop to about 17.3 million animal units in 1935, a reduction of about 17 percent since 1920.

The range portion of the Plains States, the 11 far Western States as a group, and most of them separately, show similar downward trends from different peak years.

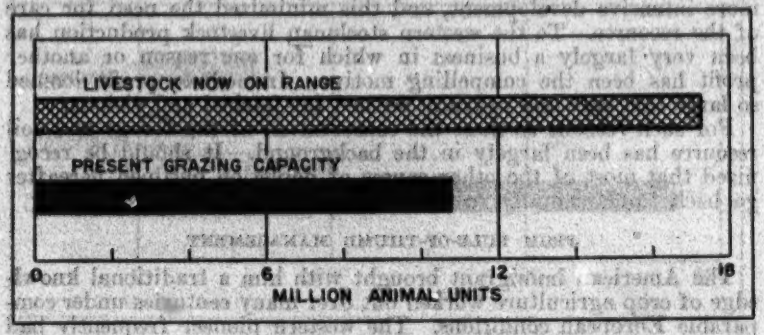


FIGURE 7.—EXCESSIVE STOCKING

Excessive stocking has been one of the prime factors in range depletion, and until about 6.8 million animal units of surplus stock are removed the range will continue on the downgrade.

The downward trends do not in themselves tell the whole story, because many herds are being carried on a bare maintenance basis by subsisting chiefly on low-value plants. Overgrazing for an extended period destroys the choicest range species first, and the livestock turn progressively to the poorer and poorer plants which, although grazed, are not as nutritious as the original vegetation. Accordingly the full extent of damage to the range often has not been fully reflected in decreased grazing capacity. Overgrazing has left its earmarks in the scarcity of the choicest range plants and the predominance of low-value and worthless plants, in dead or partly dead stumps or stubby branches of shrubs, in noticeable damage to tree reproduction, and in erosion and barren soil. Such earmarks are now conspicuous on several hundred million acres of range lands and particularly on those depleted in excess of 50 percent.

If any other evidence of excessive stocking is required it is necessary only to compare the 17.3 million animal units dependent on the range in 1935 with the estimated grazing capacity of 10.0 million animal units (fig. 7). In other words, it would be necessary to

reduce present stocking by nearly 38 percent to meet the actual grazing capacity. Even humid pastures could not stand up under such abuse; it is far too much to expect of semiarid ranges.

But the evidence of overstocking does not stop even here. Average annual death losses on overstocked and overgrazed ranges of as much as 9 percent among sheep and 5 to 7 percent among cattle are practically double the losses under conservative grazing and good feed. Calf crops on overstocked, overgrazed ranges are often only a half or two-thirds of what they are under good conditions. Other specific evidence, historical and otherwise, of overstocking and depletion, could be multiplied almost indefinitely.

And overstocking is only one, and the most serious, of the defective rule-of-thumb forms of management which have hastened and accentuated depletion. Poor distribution of livestock, concentration on key areas such as mountain meadows and around watering places, grazing at the wrong time of year, faulty balance between classes of animals and type of range, grazing two or more classes on ranges already overstocked with one, have contributed in varying degree and very largely in the aggregate.

When the stockman realized what rule-of-thumb practices were doing to the range, he often was, or thought he was, under the compulsion of other causes which stayed his hand.

FROM AN UNSOUND LAND POLICY

A national land policy unsuited to the semiarid and mountain grazing lands of the West has been still another major cause in the depletion of the range forage. This policy has grown out of such factors as:

1. Belief in universal private ownership of land and the attempt to pass as much land as possible to private ownership regardless of its character.

2. In this attempt, the practically unmodified application to the radically different semiarid West of land laws suited to the humid East and Middle West.

3. The failure to classify land as a basis for alienation according to the economic suitability for private ownership or to its highest form of use.

4. The character of the interpretation and administration of the land laws.

The first alienation to private ownership occurred in the Southwest before American acquisition, as Spanish and Mexican land grants, and amounted to more than 45 million acres. These grants were based on the philosophy of a landed aristocracy rather than that of democratic equality, which was one fundamental basis of American land disposal. Although averaging several thousand acres each, they have not generally resulted in good range management and are depleted almost as badly as the surrounding lands.

Homesteading in the West dates back largely to the homestead law of 1862. More liberal amendments and new laws have included the enlarged homestead law of 1909, the Kinkaid Act of 1904, and finally the stockraising homestead law of 1916.

Neither the maximum of 640 acres available under the stockraising law nor the 160 acres under the original Homestead Act offered the

remotest possibility of supporting a family under range use. The attempt at classification, made under the Stockraising Act, finally listed practically everything short of absolute desert. The ineffectiveness of the classification has been partly responsible for abandonment before the passage of title of some 23 million acres out of the 68 million acres entered. Under the Homestead Acts up to 1935, 1.4 million entries were made for nearly 240 million acres, a substantial part of which was in the range country and more than half of the western homestead area was range land.

Railroad and wagon-road grants, totaling more than 101 million acres of odd-numbered sections of range and other lands, checkerboarded wide strips across the West and further complicated range use and contributed to depletion. The railroad land policy has been to cash in as fast as possible by sale, and about 65 million acres of range land, mostly in small tracts, has gone into other private ownership, leaving more than 19 million acres of the poorest grant land unsold, most of it range, and in the original checkerboard pattern. For this their policy has generally been to get the maximum current revenue through leasing. Most of the railroads have recently reversed this policy, however, and are working toward some stable and orderly use of the range resource which they still retain.

Texas retained its public lands and has based its land-disposal policy on that of the Federal Government, except that considerably larger areas have gone to single owners. Depletion has, however, been much the same as on smaller private holdings.

Federal grants to the other western States were for common schools, institutions, and internal improvements. Through selection under institutional grants and by use of the various lieu-selection laws there has been considerable consolidation. Most State land was, however, in scattered sections. It has been sold where the legal price could be obtained, and the remaining area leased for the maximum current revenue. These lands have been handled by agencies whose primary function was disposal and revenue collection, and in no instance by agricultural agencies. A total of about 33 million acres has gone into private ownership. Since stockmen have followed their own inclinations in the handling of leased State lands, the extent of depletion is practically identical with that on lands in private ownership.

The 149.4 million acres of range land available for grazing left in the public domain, grazing districts, and other withdrawals is the poorest west of the Mississippi. It is the land which for its surface rights no one would take as a gift or purchase under the homestead or other land laws. Much of it is badly scattered. Open without restriction or restraint to all or to any who could take or hold, no other class of range land has suffered more seriously. Along with nearly three-fourths of the forage has often gone the top soil on which future recovery must depend.

The sum total of the effects of past land policy on range land has been:

1. A crazy-quilt ownership pattern, such as that shown in figures 63 and 64, made up of several hundred thousand small farm or ranch units, widely scattered State holdings and railroad lands, the foreclosures of insurance and investment companies, banks, etc., isolated Federal public domain tracts, and State and county tax-

delinquent lands—all of this almost impossible to handle effectively because of size or surrounding holdings and leading inevitably to overgrazing, depletion, and social and economic instability of the dependent population.

2. The passage to private ownership of an enormous area of land, the size of which is not yet accurately known, that is either submarginal even for range use by private operators because of low productivity, etc., or has high public values such as watershed protection which are difficult or impossible for private owners to maintain.

3. The passage to private ownership and encouragement of dry and other farming of some 50 million acres of relatively good range land that is submarginal for crops. Nearly 25 million acres have already been abandoned for cultivation and at least 11 million acres additional constitute acute problem areas. On all of this area the range has been destroyed and will be of little use for years to come unless reseeded.

4. The passage to private ownership of key areas, such as water holes, giving control of very much larger areas of public land, and as spring range of which there is a serious shortage.

5. Tax delinquency on the ranges submarginal for private ownership, and delinquency on and abandonment of the dry-farming areas which the meager data available indicates to be excessive.

6. Depletion so serious that decades of time and enormous expenditures will be required for restoration, not only of the range which has passed to private ownership but also of that outside of the national forests which has remained in public ownership.

Among the favorable features of Federal-land policy from the standpoint of range depletion has been the creation of the national forests, and the belated provision for a better handling of the Indian lands and a part of the public domain.

FROM FINANCIAL HANDICAPS

One of the greatest financial handicaps of the western stockman in comparison with his middle-western competitor is a serious freight and marketing differential. On an 1,100-pound steer, for example, Illinois has an advantage in the Chicago market over Idaho of nearly $8.50, and over Nebraska of about $2.85 (fig. 8). The outstanding competitive opportunity which the western stockman has to offset this handicap is cheap feed from natural ranges. On the average range feed worth $1 or less will support an animal satisfactorily as long as hay or other supplemental feed costing $5 to $10 or even more (fig. 9).

Instead of maintaining fully this natural advantage of cheap range feed, however, the western stockman has ordinarily followed one, or usually more, of three other courses which have actually increased his handicap. In all of these he has tried to carry too many stock. Hoping to reduce costs of production he has overgrazed and destroyed his cheap range feed. He has bought crop lands and grown and used excessive amounts of high-cost hay and other supplemental feeds. He has purchased range lands often under competitive conditions which have inflated values, increased his capital investments, and hence the costs of production.

The investment in land in the livestock industry is so high in many cases that the livestock or converting part of the enterprise cannot earn a profit. Overcapitalization in land supplemented by the leasing of land in competition, the purchase or growing of relatively costly supplemental feed, and exorbitant interest on borrowed funds have all contributed to high production costs. In Montana, for example, the ratio of investment in land, improvements, etc., to the ewe value per head was 0.5 to 1 in 1890, but had increased to 4.7 to 1 in 1932. In an attempt to restore the balance between land and herd investments and to reduce production costs, stockmen have ordinarily increased their herds and overstocked and depleted their ranges.

Unfavorable credit facilities have added to the financial difficulties of the livestock producer. Boom credit has been so easy that it has almost been forced on him and has contributed to overexpansion in both land and herds. During depressions when he has most needed credit it was difficult or impossible to obtain, and he has had to dump stock on glutted markets or frequently to hold them on ranges already seriously overstocked.

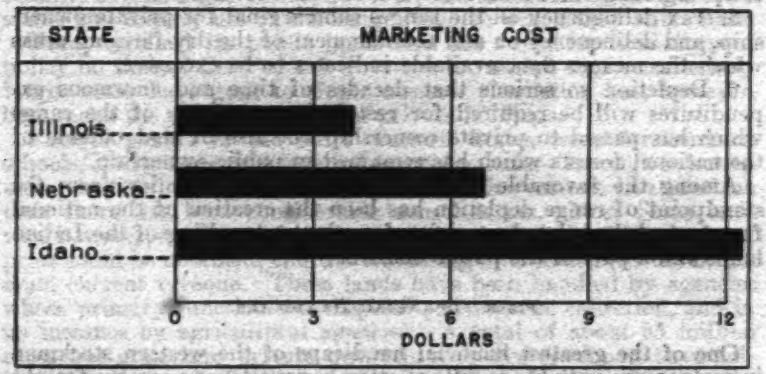


FIGURE 2.—THE MARKETING DIFFERENTIAL.

Marketing costs, mainly freight, are one of the most serious financial handicaps of nearly all the range country. Idaho's handicap over Illinois in the Chicago market of nearly $3.50 on an 1,100-pound steer, can be met successfully only by some decided compensatory advantage.

Beyond this, loans have been predicated almost entirely on livestock as the basic resource without taking into account the range upon which they fed, and this again has contributed to overstocking and range deterioration. Short-term loans at interest rates often as high as 9½ or 10 percent have increased costs, reduced profits, and added to the hazards of the enterprise and its disregard of the basic range.

Widely fluctuating markets from year to year and almost from week to week, have capped the climax of their financial difficulties. Depressed and glutted markets in particular have helped to keep stock on the range where already numbers were far in excess of what it could support.

Accordingly the financial and market set-up of the stockman has always been difficult and sometimes almost impossible. That this

situation has always borne hardest on the holder of land submarginal for private ownership, the user of badly depleted range, and the unit which was uneconomic because it was too large or too small, or was poorly balanced between range and crop land, and between land and herd, requires no proof.

With the financial cards stacked against him to a greater or less extent the range user has made the fatal mistake of trying to break even by crowding more stock on the range. As a result the range deteriorated still more rapidly and this in turn accentuated his financial handicap.

In this involved and ordinarily adverse situation the stockman has not been entirely a free agent. His course of action may not have been sufficiently aggressive and constructive and he undoubtedly failed to appreciate or may have seriously underestimated the bearing of it all on his basic resource and what the end result would be. However, in part at least, he has been the victim of circumstances far beyond his own control.

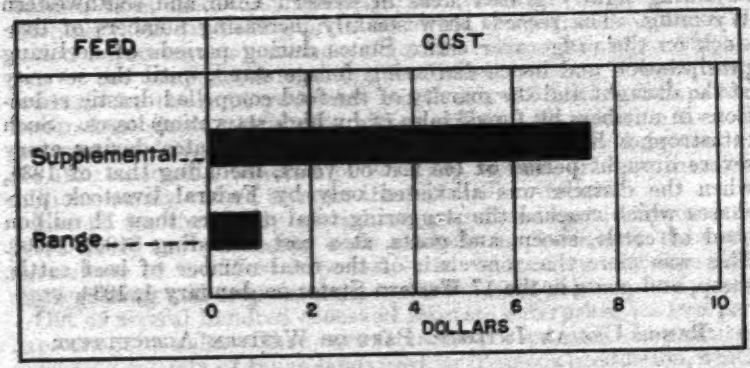


FIGURE 9.—CHEAP RANGE FEED THE ANSWER.

Cheap range feed, the one best answer to the marketing differential, has unfortunately been largely lost under unrestricted grazing, practically universal depletion, and excessive use of the several times more expensive supplemental feeds.

FROM THE CLIMATE

Last, but not least, among the primary causes of depletion is the climate.

Precipitation in the western range country averages less than 15 inches, or only about one-third that of the East. Excepting the higher mountain areas, it varies from about 15 inches in the short-grass plains to less than 5 inches in the southern-desert shrub type of the Mohave-Gila Desert of the Southwest.

For single years or, often, for groups of years it falls below the average. An extreme of 2 to 4 years out of 10 are drought years over much of the Southwest. Severe droughts often lasting several years have occurred over much of the West in every decade since 1880.

The volume of range forage produced depends upon climate and especially upon the amount of precipitation. At the extreme, the reduction in forage production in very dry as compared with favorable years may reach over 90 percent in the semidesert grass and southern desert shrub types in New Mexico and Arizona. Over large areas the fluctuation may be as much as 80 percent in successive years. Under even the most favorable climatic conditions the recovery in production is not complete in a single year, and under average conditions probably requires from 3 to 5 years. Under adverse conditions it requires still longer.

Neither the climate nor the amount of precipitation can be controlled by man, but the numbers of stock on the range can. The almost universal failure to vary the numbers of stock with such fluctuations in the amount of forage produced, or to stock below production in average years, has been one of the primary causes of depletion. For example, from 8 to 10 times as many valuable forage plants died during the 1931–35 drought on heavily grazed as on adjoining lightly grazed areas in western Utah and southwestern Wyoming. The records show steadily increasing numbers of livestock on the range over entire States during periods of declining precipitation and hence decreasing forage stand, until the severity of the drought and the scarcity of the feed compelled drastic reductions in numbers by forced sales or by high starvation losses. Such catastrophes have occurred in most Western States during every severe drought period of the last 50 years, including that of 1934, when the distress was alleviated only by Federal livestock purchases which reached the staggering total of more than 11 million head of cattle, sheep, and goats, at a cost exceeding $100,000,000. This was more than one-sixth of the total number of beef cattle, sheep, and goats in the 17 Western States on January 1, 1934.

Range Use an Integral Part of Western Agriculture

The growing of domestic livestock on open ranges, their production on fenced pastures, and the production of farm products on cultivated land are merely different phases of agriculture. But the extent to which range use is related to and, in fact, an integral part of western agriculture is another major finding of this report.

Range use by domestic livestock in the West probably began in New Mexico about 20 years before the Pilgrims landed at Plymouth. It was not until nearly 280 years later, with the cattle boom of the eighties, that heavy use over large territories became a major factor in range depletion. Cattle and sheep had increased to an early peak in California about 1875. From 1870 to 1880 all the other Western and, especially, the Plains States showed exceedingly rapid increases in number of cattle. Texas chiefly, with more than 4.5 million cattle during the seventies, supplied the other Plains States. Sheep spread rapidly over the western ranges between 1890 and 1910.

Irrigated crops as an adjunct to range use were grown along the Rio Grande from about 1700 on. Even in the 1850's during the early stages of the range livestock industry, which at first was almost wholly pastoral, crop farming began in California and Utah. The first homestead patent was granted in 1869 in Nebraska. The cut-

ting of native hay began in the seventies. In parts of Idaho range livestock grazing proved very difficult until crop agriculture produced the feed needed to carry stock through the winter.

Beginning in 1910 large irrigation projects have been an important factor in furnishing supplemental feed and concentrates for feeding and fattening range livestock. The 242,908 farm units and 93,797,000 acres of land in farms in the 11 far Western States in 1900 had by 1930 more than doubled in number of units and in acreage.

In sum, grazing, which at the beginning was largely an independent and pastoral enterprise, and which after a long, slow start expanded ahead of and more rapidly than crop agriculture, has now become vitally dependent upon crop production. The latter also started early but has grown more slowly, and reached large proportions several decades later.

The combined range and crop agriculture now constitutes a substantial part of the total wealth of the West. The 1930 census values western farm lands and buildings, and farm and range livestock, machinery, etc. (including privately owned range and excluding irrigation improvements), at more than 12.9 billion dollars, or 23 percent of the comparable total for the United States. Western crop products for the same year were worth over 1.5 billion dollars and livestock products nearly 480 million dollars. In addition to beef and mutton, hides, etc., the range territory produced 75 percent of the 1930 national production of wool and mohair, or more than 276 million pounds, valued at more than 82 million dollars.

Except for the highly specialized crop farming, mostly on irrigated land, and producing such products as fruits and nuts, the agriculture of the West is primarily an integration of range livestock grazing and crop farming.

Out of several hundred thousand separate enterprises no two perhaps are quite alike. They vary from the one extreme of operations consisting entirely of range lands used for livestock production, which purchase from crop farmers the supplemental and fattening feeds they use, to the other extreme of units devoted exclusively to crop farming for the production of grain or other cash crops, where the direct tie with the range is confined to sales of supplemental feed or the leasing of irrigated pasture. In between are innumerable combinations and variations of range lands used for livestock grazing and crop lands used to provide supplemental feed for range livestock and for many different kinds of cash crops.

Land tenure differs fully as much, from the rapidly vanishing tramp sheepman who owns no range and leases little, to the baronial operator who owns outright the range and crop lands which support his stock throughout the year. In size, ownership may be as small as 5 or 10 acres of crop land, or as large as the 500,000-acre ranch, largely range, but with some crop land.

Cattle, sheep, horses, and other livestock and the meat, wool, and other materials of which they are the source, are clearly, therefore, the products of range lands only in part. The diversified products of croplands—various cereals, corn, sugar beets, cotton, flax, sorghums, hay, pasturage, etc.—return cash income only in part. Whether sold or used directly in feeding they now constitute no less

than 35 percent of the feed required for western range livestock (fig. 10).

Each major region of the West has its distinctive agricultural pattern and form of integration of range and croplands, dominated mainly by climate and topography, but partly also by economic conditions and tradition. These are described in detail in the report and repetition here would only serve to illustrate still further the tie between range and cropland use which is already apparent.

Western agriculture is the direct source of livelihood for over 1 million farm and ranch families, the principal support for another million families in rural towns, and the indirect support for a large part of the remaining population of the West. Its contributions extend from the farms and ranches through the small and exclusively agricultural communities to the larger supply towns and the metro-

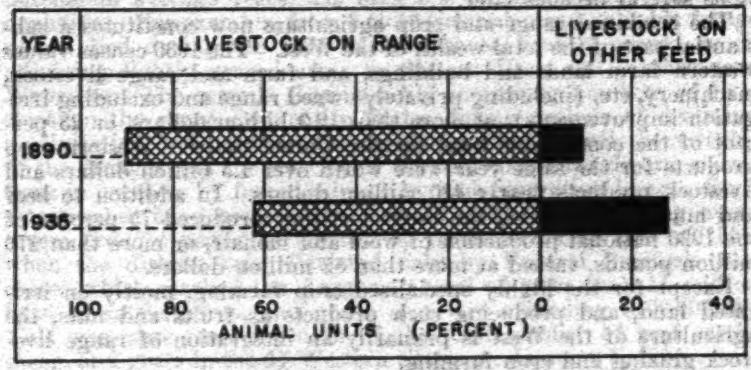


FIGURE 10.—INCREASING INTEGRATION OF RANGE AND CROP AGRICULTURE

A threefold 45-year increase in the percentage of numbers of livestock on supplemental feeds and irrigated pastures is a salient point in the increasing integration of western range and cropland agriculture.

politan centers. The grocer, druggist, miner, mechanic, lumberman, and banker, the stockyards, the railroads, and other transportation services, in fact every western activity which forms a part of the complex, interrelated, interdependent structure of modern civilization has its stake in a permanently prosperous and stable agriculture.

The somewhat arbitrary eastern boundary of the range country is no limitation, however, on the tie of its agriculture with the agricultural and other industries and activities of the remainder of the United States. The western ranges furnish feeder and stocker cattle in large numbers to the Midwest, thereby offering the opportunity for diversification of farm products and for turning slack time into cash. Both the Midwest and the South sell large quantities of shelled corn, other grains, and cottonseed meal and cake to the West. The range country and the Middle West compete in supplying the eastern consumer with various livestock products. And these are only a few obvious forms of the tie between the West and the East in which western range and cropland and their products play so conspicuous a part.

Serious Social and Economic Losses

The only way to measure the value of the range is by the social and economic yardstick, the losses from mismanagement and abuse, and the contrasting benefits from wise use. The character and extent of such losses and benefits constitute another major finding of this report.

Close integration of range and cropland use carries with it an equally close dependence. Maladjustments or deterioration or destruction in either one inescapably reacts upon the other. The problems of one are inevitably the problems of the other. What benefits one benefits both. The free play of economic forces has gone so far in the welding process that it is impossible to escape the fundamental soundness of this relationship.

IN LIVESTOCK PRODUCTION AND RELATED CROP AGRICULTURE

Most spectacular among the maladjustments in range land use, because of both the originality and daring of the attempt and the completeness of the failure, has been the effort to use it in dry-land farming. As indicated, the attempt has covered a total of over 50 million acres, about half of which has been abandoned for cultivation, much of it even before going to patent. Many of the remaining occupants are on relief rolls. During favorable crop years it added greatly to American and world surpluses of such crops as wheat.

Dry-land farming utilized some of the finest range lands and crowded the livestock onto lands already overstocked. It occupied large areas of spring ranges already too small to meet requirements and forced stockmen to hold their herds on pastures and hayfields so late in the spring that these also were more or less seriously damaged. The reoccupation of the abandoned lands by valuable forage plants is very slow. At least 15 million acres will have to be reseeded artificially at a cost so high that it probably can be borne only by the public.

A more serious but less spectacular maladjustment has been the passage to private holders of many millions of acres of range land submarginal for such ownership. The fact that some 150 million acres of range lands in the public domain, grazing districts, and other withdrawals, and most of the additional 58 million in State ownership has not been transferred to private ownership has been a clear-cut recognition that some range lands are submarginal for private holding.

But for range lands once transferred an entirely different psychology has held. It has taken several decades of private ownership, waves of failures following repeated efforts culminating in a combination of one of the worst depressions and worst droughts which the West has ever experienced, even to raise the question seriously.

The question has not arisen earlier in acute form because the private owner has been living on a range and soil capital built up by natural processes over thousands of years which has only now become so largely dissipated that he must face realities; because he could to some extent supplement the deficiencies in his own hold-

ings from a free public domain now passing out of the picture; and because of the tenacity with which the average American has held to the belief that he could in some way work out his own salvation on almost any land however unproductive.

Two classes of range land fall into the submarginal class for private ownership: Those (1) with a very low grazing capacity because of poor soil or adverse climate or both, or because of severe depletion under conditions so adverse that many years of light stocking will be required for rehabilitation; those (2) on which the range has been destroyed by cultivation and must be restored artificially at high cost.

Most of the southern desert shrub type, which has a grazing capacity of only four to five cows per section of land, illustrates the extreme of the first class. This poorly watered land may require the excessively high investments for water and fencing alone of $50 to $75 per cow.

A drought expectancy of 2 to 4 years in 10 in most of the semiarid Southwest, as compared with 1 to 2 years or less in the sandhills of Nebraska, is reflected in forage production so low in the drought years that the only alternatives are heavy starvation losses or high supplemental feeding costs.

When on many millions of acres grazing capacity has been reduced by 50 or 75 percent or more, and 5 to 10 acres are required to carry one cow for a month, the costs of production are correspondingly increased, and if to this is added the long period of very low stocking required for restoration, the possibilities of profit under private ownership may be removed for years to come.

The vegetation destroyed by cultivation on lands of the second class can be restored artificially at a cost of $50 to $100 for enough range to carry a cow a year, and this cost may be no higher than that of carrying the land for the time required for natural restoration of the forage. Whether private owners can carry this burden on top of other production costs, except on the very best lands, is questionable.

The adverse marketing differential already discussed holds for both classes of land in all of the far-western States except California, and accentuates low inherent productivity and depletion, or both combined—especially because of the need for cheap range feed to meet midwestern competition.

So also does taxation, which bears most heavily on the poor and most seriously depleted lands. The operator whose range will support only one animal per 100 acres year long and who pays a tax of 5 cents per acre, which amounts to $5 per animal unit, labors under a handicap so serious that again serious question of the feasibility of private ownership is raised.

High tax delinquency in many parts of the range country is at least a symptom of something so seriously wrong that it will not be cured by returning the lands to private ownership. And to all of this evidence must be added the low standards of living and high relief rolls in some range country.

The information now available does not permit any exact determination of the area of range land submarginal for private ownership, but it probably runs into scores of millions of acres.

The Federal and State land legislation and policies already described transferred to private owners hundreds of thousands of range-land units too small for the support of a family. The result has been a long, slow, and painful adjustment in which both owners and the range have suffered. Between 1910 and 1930 alone the number of ranches in the 100- to 174-acre class in the 11 western States decreased by more than one-third, and the number of units over 1,000 acres more than doubled.

The availability of small units encouraged oversettlement, and this coupled with the effort to build up units of favorable economic size and the growing shortage of feed led to competition for land, inflated values, higher costs, and lower profits. It was a part of the vicious circle of more cattle in the effort to meet higher costs, and of more land to carry more cattle. The already depleted range lost the little chance it had.

Land policies also made possible the acquisition of key areas such as lambing grounds, water holes, beef pastures, and holding grounds, so that frequently the ownership of very small tracts permitted the control of large areas of range. The smaller and weaker stockmen were at the mercy of the stronger key-area owners.

Range depletion has had a long series of adverse effects on both crop and livestock growers.

Depleted ranges and abandoned farms serve as a breeding ground for the beet leafhopper. In six counties in Idaho in 1934 alone this pest reduced the beet crop by 90 percent. Two beet-sugar factories did not open and 500 people were thrown out of employment for the manufacturing season.

Range depletion, among other causes, has forced stockmen to the excessive use of supplemental crop feeds which may cost from 5 to 10 times more than range feed. Supplemental feed has its proper place in finishing for the market and for winter use. And supplemental feeding induced by overgrazing has in turn been one of the causes of depletion by keeping many more livestock on the range than it could carry.

Range depletion and at times the lack of home-grown supplemental feed or its relatively high cost has been responsible for shipments of poor or half-fat beef and lambs, and this cuts heavily into possible profits.

The benefit of long years of effort to build up good breeding herds has been lost in part through lack of feed. At Miles City, Mont., calves from good range were 48 pounds heavier at weaning than those from overgrazed ranges. In New Mexico there was a difference between rehabilitated and heavily grazed ranges of about 200 pounds in cow weights.

Both calf and lamb crops are decreased and annual losses are increased when there is too little range forage. Chronic emergencies and forced sales, which are commonly due to drought and depressions, could often be minimized by ample forage and commensurate crop land.

Federal feed and crop loans have been necessary on a large scale in part because of maladjustments and depletion. That the November 1935 percentage of repayment in the western range country is about 44 percent as compared with 62 for the country as a whole is significant.

Maladjustments and depletion have caused serious decreases in population with correspondingly bad effects on the social and economic life of the communities. Fifteen representative dry-farm counties in six States, for example, lost from 4 to over 40 percent of their population in the single decade ending in 1930.

More than enough examples have been given to show that a wide diversity of economic and social losses results from range depletion and crop- and range-land maladjustments. The greatest possible security should conversely result from ranges restored and maintained in high productivity, from privately owned units of economic size with a proper balance in area and productivity of range- and crop-land, and from a proper distribution of land between private and public ownership.

FROM EROSION AND FLOODS

In a region of meager precipitation such as most of the West, the availability of water for irrigation, municipal purposes, power, etc.,

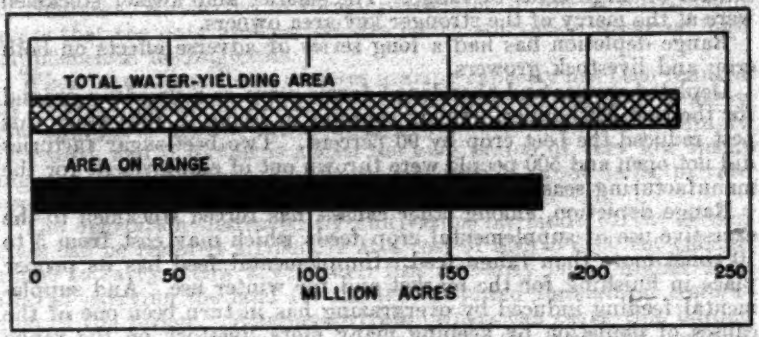


FIGURE 11.—WATER-YIELDING AREAS

Four-fifths of the 232 million acres which produce 85 percent of the water in the major western streams comes from range lands, and low precipitation makes water the limiting factor in nearly all western development.

is in most cases the factor which limits development. All plans for agricultural and municipal security as well as for most other industries must take this definitely into account.

Approximately 85 percent of the water of the principal watersheds of the West is derived from an area of about 232 million acres. Of the utmost significance is the fact that four-fifths of this important water-producing area is made up of range lands (fig. 11).

An additional reason for consideration is the fact that no less than 589 million acres of range lands, according to the best available information, is eroding so seriously that the destruction which it causes compels attention. Still further, 352 million acres of this area is contributing an appreciable amount of silt to major streams (fig. 12).

Watershed values have been most seriously impaired on the public domain and on private lands. Approximately 140 million acres, or 98 percent of the available public domain and minor reservations, is eroding more or less seriously, and 67 million acres is contributing

silt to major streams (figs. 13 and 14). Over 80 percent of private land is eroding and 195 million acres is contributing silt. While not so extensive, erosion on State and Indian lands is also critical.

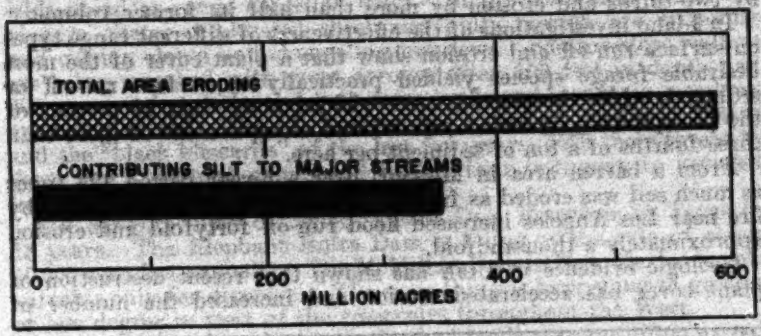


FIGURE 12.—EROSION AND SILTING OF STREAMS.

Eighty percent of the entire range area is eroding more or less seriously, and hence reducing the productive capacity of the soil. Nearly half is contributing silt in disturbing quantities to major western streams, and hence impairing their value for irrigation, power, and municipal water supplies.

Even on the national forests, which have a watershed objective in administration, 32 million acres is eroding and will require additional attention.

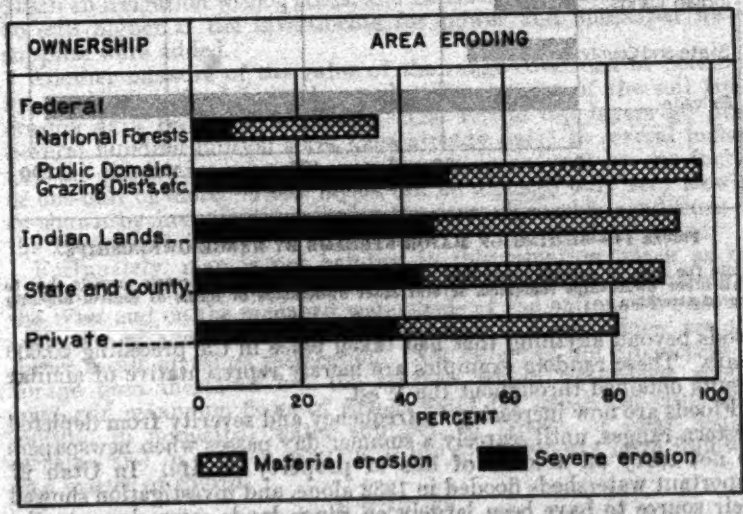


FIGURE 13.—EROSION BY RANGE OWNERSHIPS.

Erosion is most serious on the public domain and grazing districts, and Indian, State and county, and private lands are little better. Even 30 years' management has fallen far short of curing erosion on the national forests.

Scientific investigations have proved beyond a doubt that the plant cover minimizes and often prevents erosion and floods, and conversely, that depletion is a primary cause of both.

Studies in Utah to ascertain the effects of range vegetation on run-off and erosion have shown that by increasing plant density from 16 to 40 percent, surface run-off from summer rains is reduced by two-thirds and erosion by more than half its former volume.

In Idaho investigations of the effectiveness of different range types on surface run-off and erosion show that a plant cover of the most desirable forage species yielded practically no surface run-off or sediment, while the poorest cover yielded more than 60 percent of the precipitation in surface run-off and an equivalent of more than three-fourths of a ton of sediment per acre.

From a barren area in Missouri over a 6-year period 123 times as much soil was eroded as from a sod-covered area. Denudation by fire near Los Angeles increased flood run-off fortyfold and erosion approximately a thousandfold.

Geologic evidence in Utah has shown that recent destruction of plant cover has accelerated erosion and increased the number of

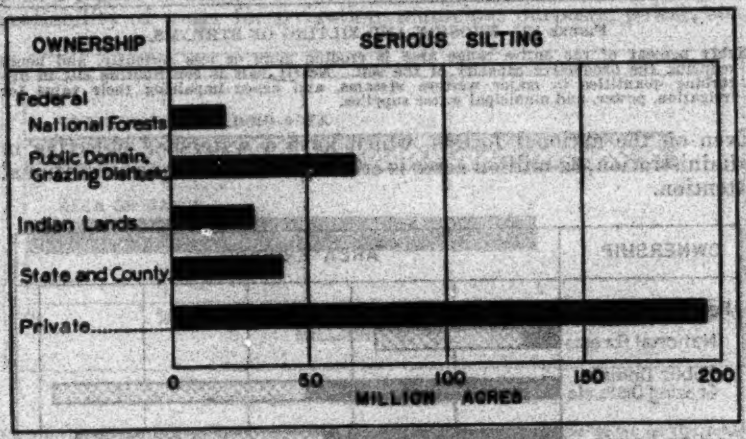


FIGURE 14.—SILTING OF MAJOR STREAMS BY RANGE OWNERSHIPS.

While the area in private ownership contributing silt to major streams exceeds that in all other ownerships combined, several other ownerships or forms of control urgently need attention.

floods beyond anything that had taken place in the preceding 20,000 years. These random examples are merely representative of similar results obtained throughout the West.

Floods are now increasing in frequency and severity from depleted western ranges, until scarcely a summer day passes when newspapers do not carry an account of loss of property or life. In Utah 27 important watersheds flooded in 1932 alone, and investigation showed their source to have been largely on range lands eaten down to the bare soil, while in New Mexico and Arizona historical evidence shows that floods are more frequent and destructive than anything which occurred in the past.

In 1923 the Palo Verde flood caused $1,000,000 damage. A Rio Grande flood in 1932 practically destroyed flood-protection improvements worth $5,000,000 and did more than $1,000,000 damage to other property. Floods in Davis County, Utah, have caused

$1,000,000 damage since 1923. The La Crescenta flood of 1934 took a toll of 30 lives and did $5,000,000 damage.

The loss of almost irreplaceable soil on the western range is as widespread as range depletion itself. In the mountains of all the western States accelerated sheet and gully erosion are stripping and cutting slopes and channeling meadows. Southwestern valleys are being trenched with great arroyos often 100 feet in depth and 300 or more feet wide, and both mesa lands and mountain meadows are being ruined. The silt loads of the rivers of the Great Plains and the "black blizzards" of the last few years, with their threat to farm and industrial values and health, bear testimony to ravaged lands.

Silt deposits filled the small Austin Dam Reservoir in Texas in 13 years. The Elephant Butte Dam is filling at the rate of about 20,000 acre-feet annually. The McMillan Dam in New Mexico is now valuable only for diversion. The same thing is happening in greater or less degree in most of the reservoirs throughout the West.

The grazing value of range watershed lands may not often exceed $3 per acre. The watershed value is much more difficult to determine. Some indication of relative values may be gained, however, from a consideration of dependent investments. More than 5.8 billion dollars is invested in irrigated land and improvements, as compared with about 4.1 billion dollars in range livestock and related ranch properties. Each of the 475 million acres of range land yielding water or contributing silt to streams supports an investment of $12.27 in irrigation works, lands, and facilities, and this figure would be still higher if the investments for power and municipal water supplies were added.

Another measure of the value of the range cover can be obtained by considering the loss in the productive capacity of the soil from erosion as a result of depletion. The fertile top layers go first. Several hundred million acres have already lost 1 to several inches, and the productive capacity may have been reduced by one-fourth or one-half or more. These layers can be replaced only very slowly, as shown by investigations under the more favorable conditions in the East which indicate a rate of about 1 inch per 1,000 years.

Fortunately, man is not helpless in this situation, black as the picture now is. On many of the protected municipal watersheds of the West and on the managed watersheds of the national forests are examples of arrested erosion and controlled floods which are the direct result of range restoration. Not only has the production of forage been increased but the services which watersheds should render in maximum flows of usable water for dependent crop agriculture, in municipal water supplies, in power, in clear fishing streams, and in greater security to life and property have followed as a matter of course.

IN WILDLIFE

Wildlife is one of the natural products of the range. Its present annual economic value is estimated at more than $90,000,000. To evaluate its economic significance, however, expenditures exceeding $40,000,000 by hunters and fishermen should be added, and, in part also, those by recreationists of over $155,000,000, because one of the

intangible but chief values of wildlife is the increased recreational attraction and enjoyment which it affords.

No one familiar with wildlife requirements will question the statement that the range with little or no impairment in its value for other uses could support a vastly larger wildlife population. So far, in fact, have numbers been reduced that any recital of what remains is in itself an indication of both tangible and intangible social and economic losses.

A few outstanding examples will suffice. The former millions of buffalo have declined to the few thousand on reservations; the thirty or forty million antelope to about 65,000; the few mountain sheep, goats, moose, and grizzly bear left are barely holding their own; the scattered remnants of upland game birds and fur bearers are still declining; the reduction of waterfowl has become a matter of national concern. Most of the big-game animals have been crowded off their original range into much less favorable conditions.

The chief factors and causes which are responsible for the present situation, discussed in detail later, need only be listed here:

1. The deterioration of the habitat through range depletion which has destroyed both food supplies and cover for land animals and birds and silted fishing streams.
2. Complications growing out of the passage of large areas of land to private ownership under a policy which offers no incentive to the owner to protect and maintain wildlife.
3. Maladjustments in land use, such as swamp drainage, that have attempted but failed to use for agricultural crop production land which would render its highest social and economic return in wildlife production.
4. Unrestricted or poorly controlled hunting and fishing.
5. A series of ill-advised or poorly handled constructive measures such, for example, as game preserves, transplanting, buck laws, etc., which have created almost as many problems as they have solved.
6. Protection alone defeating its own purpose by leading to overpopulation.
7. Wildlife agencies recruited on the basis of political rather than technical qualifications.
8. The lack of adequate technical knowledge.
9. The belated development of the basic concept that game management is required, having for its purpose production as a crop with provision for the annual harvesting of the production or surplus, this in proper correlation with other legitimate uses of the range.

The fundamental cause, however, is again the typical American philosophy of prodigal destruction rather than the conservation of natural resources.

Public interest in wildlife has increased very rapidly during the last few years, the direct result of the efforts of many sportsmen's and other associations and of State and Federal agencies. Although many of these activities have not reached the fundamental problems, nearly all have constructive aspects. Through them, for example, State agencies have contributed toward the rehabilitation of the wildlife resource. The Biological Survey has established a number of migratory bird and other reservations, controlled predatory animals injurious both to wildlife and domestic livestock, controlled range-

destroying rodents, and conducted research necessary as a basis for wildlife management. The Bureau of Fisheries and numerous State agencies have stocked many western streams and cooperated in their improvement.

The national forests have had a more important effect on the rehabilitation of wildlife in the range country than any other measure so far adopted, and are a concrete, although far from perfect, indication of the possibilities. National forest increases, which for big game animals alone are about 75 percent in the last decade, have been brought about with very little reduction in other forms of use, such as livestock grazing. The reappearance of wildlife has undoubtedly been one of the factors responsible for over 38 million visitors in the national forests in 1934 as compared with 3 million in 1917. These increases have not come without difficulties growing out of rigid State laws which stood in the way of reducing surpluses regardless of whether feed was available to keep the game from starving, or of the legitimate requirements for livestock or other forms of use, nor without other difficulties in working out effective cooperation between State and Federal agencies.

IN RECREATION

During the past half century public opinion regarding the social necessity of outdoor recreation, not alone for the favored few but for all, has undergone as radical a change as that regarding bathtubs and night air. People generally have learned that modern life makes demands for which the most practical remedy is periodic association with nature. The needs and the benefits are both physical and mental.

If increased opportunity for wholesome outdoor activities is not provided, existing play areas will be so crowded that only partial returns for expenditures of time and money can be obtained, and greater leisure time may not as it should contribute to health and happiness. The American people have developed a mobility which dwarfs into insignificance the outdoor spaces that can be dedicated exclusively to recreation.

Range lands, as well as others, possessing the qualities sought by outdoor recreationists have thus acquired economic values which often exceed those for other services. They are capital assets of their communities. They draw large sums of money that otherwise would not be received; money which contributes as fully to economic security as that from any other source.

People do not as a rule pay directly for the privilege of enjoying scenic charm or other recreational values, but they do pay indirectly through purchases of commodities and services for which there otherwise would be no local market. The recreational use of lands means that the market is brought to the resource without cost of transportation.

The serious depletion of most range areas, the reduction in wildlife, the erosion and silting of streams, have all been reflected in impaired recreational values. Where originally the mind was inspired by views of grass-covered and flower-studded slopes, it is now depressed by the sight of a terrain scored and dissected by

erosion and only thinly covered by plants. Healthful recreation from hunting and fishing have also been greatly curtailed.

Recreational use may entail changes in grazing, farming, etc., against which objections may be made. All members of a community share in its prosperity. In communities which make full use of all natural advantages, local demands establish good markets and prices, property values are increased, and local institutions are maintained at higher standards. Thus the entire community, including the industrialists, benefit from the multiple use management of natural resources to a degree which frequently offsets or exceeds possible losses from restriction in grazing or other forms of use.

These facts are amply confirmed by a quarter century of national forest administration. The traditional purposes of the national forests were primarily utilitarian, timber production, watershed protection, and forage for game and domestic livestock.

But the recreational use of the national forests has grown amazingly, as shown by the elevenfold increase in the estimated number of visitors to over 38 million in the 17 years ending in 1934. Some changes in the use of timber and ranges have been necessary on the one hand and some acceptance by recreationists of less than primeval conditions on the other. Actually all interests are better off.

In the light of national-forest experience it seems inevitable that the administration of other publicly owned range lands, both Federal and State, having recreational value will, if they are to serve the highest public interest, have to take recreational needs into account along with those for grazing, watershed protection, and wildlife. That recreational use has a place on privately owned range lands as well is clearly shown by the present status of dude ranching.

IN DEPENDENT COMMUNITIES

The small agricultural communities throughout the range country suffer both directly and indirectly from any and all the factors which reduce the prosperity of, or otherwise adversely affect, either crop or range agriculture, as the mere listing of a few of the connections will show. The local merchants who depend largely upon rural trade; the mechanics and laborers; the professions such as medicine and law; the semipublic organizations such as churches; the public institutions such as schools and the public activities such as highway construction and maintenance, all of which are dependent upon taxation; the well-being of all of these and many more fluctuates immediately and directly with that of their agricultural constituency.

It is equally obvious that the small agricultural community is merely the stepping stone to the larger supply centers which serve the agricultural regions, and these in turn to the larger western cities. Directly and indirectly involved also are the railroads and other transportation facilities, the banks, and industries such as lumbering which at first thought seem remote but which actually depend in part for the sale of their products upon the ability of agriculture to purchase.

In the complex present-day civilization with its high degree of specialization, maladjustments in any one important part extends directly or indirectly into most or all of the rest, locally, regionally,

and even nationally. It is a delicately balanced mechanism exceedingly sensitive throughout its entire working to a disturbance affecting any one part.

IN HUMAN WASTAGE

By far the most serious result is human wastage. What sum total of human wastage has grown directly and indirectly out of the depletion of the western ranges and the maladjustments in the use of range and interrelated croplands will never be known. That it has been very large there can be no doubt. Neither can there be any doubt that the struggle has served to develop a strong, resourceful, self-reliant group of survivors who form a most desirable addition to American citizenship.

Much of the wastage has been so insidious and obscure that it is never traced back to its fundamental causes. Successive waves of failures under the more adverse conditions, such as the lands submarginal for private ownership, the wrecking of high hopes and aspirations, and the hopelessness and despair and the lowering of initiative and self-reliance that grow out of failure, the melting away of lifetime savings, the casting adrift of thousands of families to become a floating instead of a stable population, reduced standards of living, uncompleted education, and other lost opportunities, all of these and many more are the barest indication of what unrestrained exploitation and destruction mean in terms of human happiness and well-being.

In part the human wastage was the price which had to be paid in a pioneering enterprise. But in much larger part it is the price of glaring and unnecessary mistakes. Any conclusion to the contrary is the saddest kind of a commentary on American efficiency. Certainly the possibility of eliminating or reducing human wastage in the future is the most compelling justification for the restoration of the range resource and the permanent maintenance of its productivity for the highest forms of use.

Range Conservation the Exception

The black range cloud like all others has its silver lining. Some pitifully small areas have been spared, and what is even more significant, other much larger areas have been rehabilitated. On the latter primarily, range management having a partially scientific basis has been developed and successfully applied. The exceptions, which have not been entirely confined to any one form of land ownership or control, emphasize the general situation by contrast, demonstrate the value of good stewardship, and point the way to the solution of the range problem (figs. 15 and 16). Their existence and the reasons for them constitute one of the major findings of the report.

PRIVATE LANDS

Approximately 376 million acres, or 51 percent of the range land of the West, is in private ownership. Theoretically the incentive of ownership should have kept large areas in good condition, but actually it has been so ineffective that the original grazing capacity

has been reduced by more than half. Only on scattered ranges and individual ranches is the range in good condition.

One wool growers' association in Idaho has maintained most of its forage in far above average condition, numbers of stock and grazing seasons have been limited, and reasonably satisfactory management has been established. A cooperative association in Montana has been equally successful. Individual ranches which have maintained their ranges through management might be cited in all States. In California a number of ranges which have been grazed continuously for over 50 years have been managed on a sustained forage yield basis. One badly depleted ranch in Marin County has been virtually

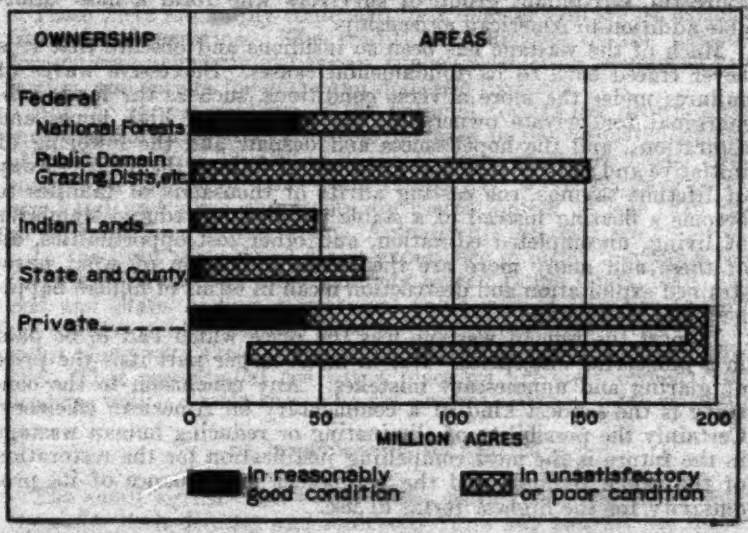


FIGURE 15.—RANGE AREAS IN REASONABLY GOOD AND IN POOR CONDITION.

Only about 95 million acres of the total range area is now in reasonably good condition, and nearly 90 percent of this is on the national forests and private lands. The reasonably good areas in other ownerships and forms of control are insignificant. Even more impressive is the size of the areas in unsatisfactory or poor condition.

restored, and a 40,000-acre ranch in Humboldt County still supports a maximum stand of the valuable California oatgrass. A 12 million-acre area in the sandhills of Nebraska, where the blowing of the soil following depletion early taught the stockmen the need for conservative grazing, has largely been maintained in good condition. This area as a whole constitutes an outstanding example of satisfactory management of privately owned range lands.

The explanation of these exceptional cases lies in various combinations of favorable natural and economic conditions—better than average growing conditions; highly resistant and recuperative forage plants; good soils; good grazing capacity; conditions which favor good stock distribution; low purchase, carrying, and production costs; balanced economic units; favorable location to markets;

the influence of national-forest management; and finally, good business and range management. Such factors as these are responsible for roughly the 44 million acres or 12 percent of privately owned range that is in good or fairly good condition.

INDIAN LANDS

More than 48 million acres of grazing land chiefly within western reservations fall into the Indian land category (fig. 17). The present condition of this range varies from reasonably satisfactory in Oregon, Washington, a portion of Idaho, and the northern Great Plains, to serious depletion on most of the area in the Southwest. Indian lands as a whole have been depleted 51 percent, and during

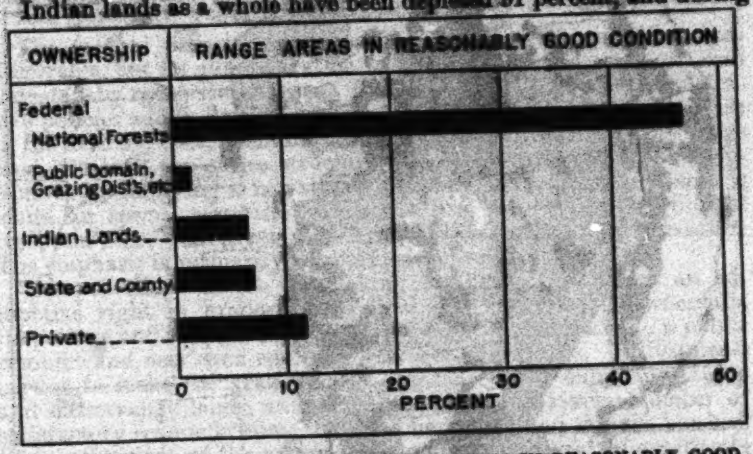


FIGURE 16.—PERCENTAGE OF RANGE OWNERSHIPS IN REASONABLY GOOD CONDITION.

When the percentage of total range areas in reasonably good condition is taken into account, the story is markedly different from that in figure 15. The national forests have the best record, but this is creditable only in the light of the condition of the ranges when management began 30 years ago.

the last 30 years the trend on three-fourths of the area has been downward, while improvement has been confined to 10 percent.

What lifts the Indian lands into the exceptional classification, however, is the extension of a definite program of management over all range lands in 1930 with the delegation of grazing supervision to the Forestry Branch in the Bureau of Indian Affairs. On the northwestern reservations, where earlier progress had been made, the program was readily put into effect. Elsewhere the major provisions of the program have been applied to the grazing of white-owned livestock. Progress has been slow, however, on ranges used by the Indians themselves, especially in the Southwest. It is hoped that through persistent effort and extension work the overstocking can be reduced. The recent Wheeler-Howard Act provides among other things for the stabilization of land status and authorizes consolidation for management purposes. All in all, while difficult problems remain unsolved, the stage has been set for satisfactory range conservation on Indian land.

GRAZING DISTRICTS

The Taylor Grazing Act (June 1934) authorizing grazing districts of 80 million acres consummates many years' effort to place the open public domain under administration. Sixty-one million acres of range lands have been included in grazing districts. More than 67 million acres of Federal lands in the unreserved public domain and

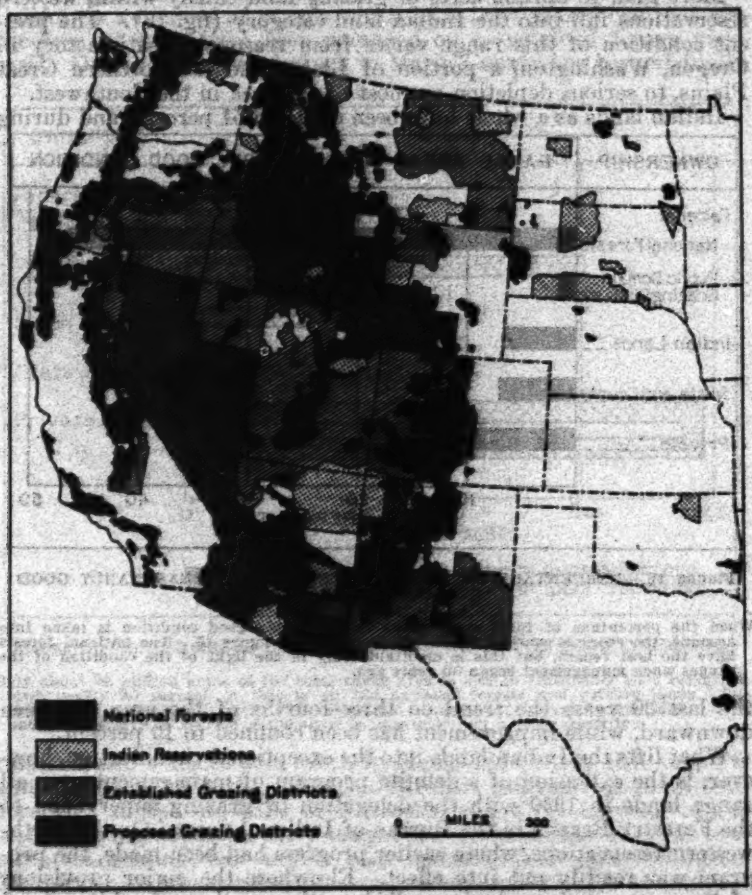


FIGURE 17.—The national forests, Indian reservations, and established and proposed grazing districts.

approximately 23 million acres in various reservations and withdrawals still lack any provision for grazing management. With average deterioration on the public domain of nearly 70 percent, which crowns a downward trend for nine-tenths of the whole for the last 30 years, this is the most seriously overgrazed and depleted range land in the United States. More than 95 percent of the available range on the public domain grazing districts and other reserva-

tions is eroding, one-half materially and one-half severely; nearly 45 percent of the area is contributing silt to important streams, wildlife values have been greatly reduced, and the utter lack of conservation measures has led to serious social and economic maladjustments.

The title of the Grazing Act lists as its purposes:

To stop injury to the public grazing lands by preventing overgrazing and soil deterioration; to provide for their orderly use, improvement, and development; to stabilize the livestock industry dependent upon the public range; and for other purposes.

The Secretary of the Interior is directed to—

make provision for the protection, administration, regulation, and improvement of such grazing districts as may be created.

The general purpose of the act and many of its provisions are admirable, but its administration may be greatly hampered, or even defeated, by restrictive clauses. Much depends upon the administrative policies adopted under its broad discretionary powers. A clause in the first sentence, "pending its final disposal", that is of the range land, weakens the entire structure and discourages far-sighted objectives by implying a transitional status. Inadequate provision is made for special watershed protection and for the conservation of resources other than grazing, such as wildlife, forests, and recreation. The emphasis is primarily on grazing utilization.

The provisions of the act making the grazing privilege an adjunctive right in proportion to land and range-water ownership, perpetuate and enhance existing monopolies in land use with a public resource and may even encourage further monopolies. Adjustments needed to make the grazing privilege more fully supplement crop and other range lands, and contribute to the maximum number of satisfactory economic home units are hampered and may be blocked. Some provisions of the act may make grazing privileges practically vested rights and prevent reductions needed for range protection.

Cooperation with local associations of stockmen and appropriate State agencies is provided. It is doubtful, however, whether this desirable feature should be made the main instrument of administration. Present indications are that local control will be largely by advisers elected by the stockmen except for supervision and basic technical criteria for conservation of the natural resources by Government personnel. The danger is that because of economic pressure stockmen will not impose sufficient restrictions upon themselves and their neighbors to rehabilitate the range and manage it satisfactorily, and that they may not amply safeguard other resources such as watersheds, recreation, and game, in which the general public is vitally interested. It is questionable whether the incentive for good management will be greater than under complete private ownership.

THE NATIONAL FORESTS

The examples of even fairly satisfactory range management are so much the exception that it is difficult to outline the progress made on the national forests without giving the appearance of partisanship.

Large-scale range conservation and management has pioneered and largely centered on the national forests. Eighty-two and a half million acres, or 62 percent of the total area of the western national forests are usable and available for grazing. Approximately 1,430,000 cattle and horses, and 6,161,000 sheep and goats are grazed several months of each year.

The national forests are the direct result of action by far-sighted, public-spirited leaders who recognized the widespread exploitation and depletion of our forest and watershed resources and the critical need for their conservation and wise use. They began as "Forest Reserves" in the Department of the Interior under the act of March 3, 1891, which authorized the President to withdraw and set apart by Executive order areas for timber production and for maintaining favorable conditions of water flow.

Up to February 1, 1905, only 63.3 million acres had been set apart, but very little progress had been made in the administration, protection, and management of the lands. The policy was more one of "locking up" the resources than of wise use.

On February 1, 1905, the forest reserves were transferred to what has since become the Forest Service in the Department of Agriculture, and later renamed national forests. President Theodore Roosevelt increased the area to 194.5 million acres, to prevent further exploitation and monopolistic control. Civil service became the basis for selection of personnel and the organization was decentralized to facilitate and localize administration.

The objectives in the administration of the national forest ranges have been:

1. *Conservation and use.*—Perpetuation of all of the resources through protection, development, and wise use.

2. *Multiple use.*—Correlation in management and use of all the resources to obtain the highest net public benefits. In such correlation timber production and watershed protection are necessarily given high priority.

3. *Equal opportunity.*—Protection of the settler and home builder against monopoly and unfair competition in the use of the resources.

4. *Integration with agriculture.*—Relating the use of range and other national forest resources to farm-grown forage crops, range, and other agricultural resources to obtain the highest benefits from all the land.

5. *Stability of use.*—Safeguarding livestock agriculture by affording maximum stability in range use consistent with national forest objectives.

6. *Cooperation with users.*—Provision for an advisory voice in national forest administration by stockmen and other users.

7. *Local administration.*—A businesslike and technical administration designed and organized to settle local problems expeditiously according to local conditions.

Except for an advisory voice which came later, regulations incorporating these basic policies were put into effect on July 1, 1905. Modifications have been made from time to time for clarification and better application.

Most range managers in the Forest Service now have both scientific training and practical experience in range administration, a gradual transformation from a staff made up largely of men with

practical experience only. They ascertain, by local study, the relative value for grazing of the various range plants, their ability to withstand grazing, soil, and other requirements for growth and reproduction, the best methods of use, and other factors, which together determine safe grazing capacity, proper seasons of use, adaptability of the range to different classes of stock, requirements for sustaining the forage production, and how to hold the soil and maintain its fertility.

Range management plans which apply these data are in effect on four-fifths of the area. Stock is controlled on the range by salting practice, proper herding, and the construction of watering places, drift fences, and other range improvements. The stockmen participate actively in management both individually on their respective range allotments and collectively through livestock associations and advisory boards.

Grazing capacity has been improved 19 percent since 1910. National-forest ranges today on the whole are 70 percent as good as virgin range, as contrasted with 33 percent on the public domain and 49 percent on privately owned range in the West. Real progress has been made in range restoration, considering the pioneer nature of the effort, the extent of depletion when the forests were established, the time required for rebuilding the soil, the rough topography, the necessity of grazing large numbers of livestock each year, the overload of livestock carried during the war period, the recent protracted drought, the desire to avoid undue hardships on the livestock industry through drastic reductions, and the time required to overcome human inertia. All of these factors have retarded rehabilitation. But the fact remains that the range has not been fully restored. Too many sore spots remain, and remedial action has been too slow on many of them. For the national-forest range area as a whole it is difficult to escape the conviction that progress should have been greater, although it may be too easy in retrospect to minimize the handicaps faced and overcome. Watershed services, wildlife numbers, recreational use, and timber production have been increased, although here also there is still ample room for improvement.

On the whole, the possibilities of range conservation, use, and management have been demonstrated, and public responsibility has largely been redeemed. Shortcomings exist, and important unsolved problems remain, prominent among which are full range restoration and a further improvement in range management, more equitable distribution of grazing privileges socially and economically, in which too little progress has been made, and more satisfactory relations with range permittees.

Resilience of Range Livestock Production

Range livestock production has shown a remarkable persistence. It has been like a patient suffering from several diseases any one of which the doctors believe should be fatal, but who continues to live a lusty, vigorous life.

Range livestock production has been a new American venture, without traditional background. For forage production it has had to contend with a climate which at best constitutes a drought more

severe than any which the remainder of the United States has ever experienced. Western droughts have periodically wiped out the gains of years. Cheap range feed has been the one great competitive advantage of the western range country under a serious marketing handicap as compared with the Middle West. This feed, by flagrant neglect and mismanagement, has been seriously damaged and in places almost destroyed. Over many millions of acres the fertile soil, slowly built up during thousands of years, has been wasted away and with it the basis of forage production. In going the soil has often carried damage and destruction to far-distant areas and communities.

Range livestock production has built up its land tenure under land policies so unsuitable that the final result is an indiscriminate mixture of holdings large and small, individual and corporate, private and public, Federal and State. It has been encouraged by competitive forces, and by public-land laws and policies formulated for entirely different conditions and transplanted with little or no modification, to assume the burden of millions of acres of submarginal land on which the private owner never had a fighting chance.

Maladjustments in the use of millions of acres of land for crop production, which widespread failure has shown to be suitable only for range, have destroyed for years to come some of the most productive range territory. In the balance of seasonal range areas and in the balance between crop and range feed a whole series of other maladjustments have crept in.

Although purely an agricultural function, the jurisdiction over Federal range lands has been split between two departments. One, charged with the responsibility for building up and supporting all phases of agriculture for the entire country, has for the past 30 years been trying on a large scale an experiment on the publicly owned national forests in the conservation of natural resources, including range, entirely new in American history. The other, charged with the responsibility for the disposal of Federal lands, has only within the last 2 years begun the attempt to administer the ranges which private owners could and would not take from the public domain. The agricultural agencies of the States have had little voice and no responsibility in the administration of Federal grants, which have been handled by agencies charged primarily with land disposal.

Range livestock production has operated under an almost impossible credit structure. It has been crushed time and again by depressions. Its markets have been controlled by outside agencies or forces, often to its detriment.

Within its own ranks it has often waged relentless war, big man against little, cattleman against sheepman. For years it fought the crop farmer, who has now become an essential part of a soundly balanced enterprise. It has all too often fought the public agencies which were attempting to maintain its resource and to solve its basic problems.

And yet possibly no other American enterprise has shown a greater resilience. None has had a greater confidence in the promise of the future or in its own ability to meet every problem which might arise. The only conclusion is a virility, an innate vitality, and something fundamentally sound in the use of range for livestock grazing

which deserves and should be given a far better opportunity in its own and in the public interest than it has ever had.

DRASTIC REMEDIAL ACTION REQUIRED

The bewilderingly complex range problem will be clarified and consideration of the program required for its solution will be facilitated by breaking it down into its component parts, many of which in themselves constitute important problems. This can be done only at the expense of some repetition of the preceding and following discussions. The reader may if he wishes skip this cataloging of problems to the point on page 40 where those of greatest immediate importance and urgency are summarized.

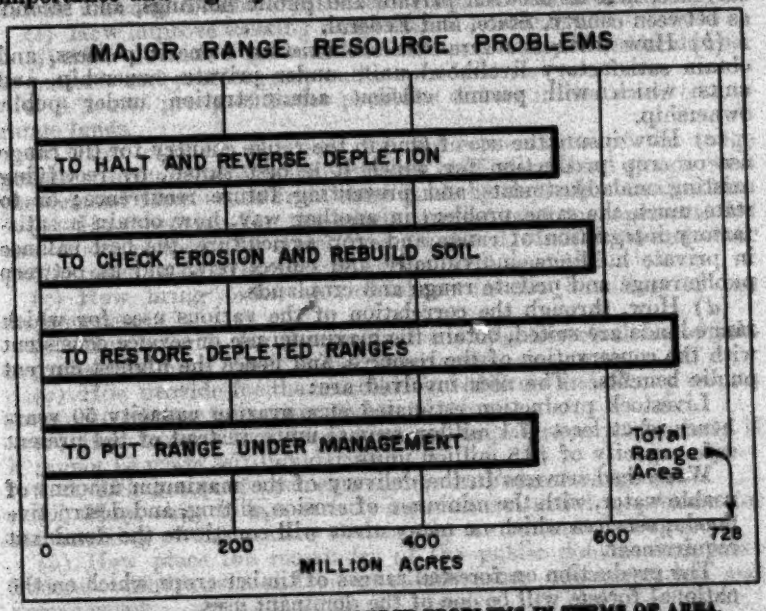


FIGURE 18.—MAJOR RANGE RESOURCE PROBLEMS IN TERMS OF AREA.

One measure of the magnitude of some of the major range resource problems is the hundreds of millions of acres on which constructive programs must be carried out. All constitute a high percentage of the total range area of 728 million acres.

The number of interrelated and overlapping problems in this break-down is so large and many of them are so crucial that no one is the key to the entire situation. They are so enmeshed in the established economic and social set-up that all solutions are fraught with extraordinary difficulties. No single feasible line of constructive action offers the remotest hope of a satisfactory solution.

1. One major group of problems centers in the range resource and its management.

(*a*) How stop further forage depletion on the 553 million acres, or 76 percent of the total range area still deteriorating, and start the forage on the upgrade (fig. 18).

(*b*) How place all range lands under management. Approximately 628 million acres is now subject to practically unrestricted grazing.

(*c*) How restore to the nearest possible approach to original productivity, and maintain in such productivity thereafter, the 675 million acres, or 93 percent of the range area, now depleted.

(*d*) How prevent further deterioration of the soil on which forage production depends on the 589 million acres now eroding more or less seriously, and start the rebuilding process.

(*e*) How restore the soil resource to the nearest possible approach to its original fertility, and maintain it at this level.

2. A second group of major problems centers in land and its ownership and use.

(*a*) How obtain the soundest distribution of ownership of range lands by curing existing maladjustments, and preventing their recurrence, first as between private and public holdings, and second, as between county, State, and Federal.

(*b*) How further unscramble the existing ownership mess, and obtain satisfactory livelihood units under private ownership, and units which will permit efficient administration under public ownership.

(*c*) How insure the use of land in the range country for the range use or crop production for which it is best suited, by rectifying existing maladjustments and preventing future recurrence; or to state much the same problem in another way, how obtain a satisfactory integration of range and crop agriculture, the best balance in private holdings, individually and collectively, and as between public range and private range and croplands.

(*d*) How, through the correlation of the various uses for which range lands are suited, obtain the maximum use or service consistent with the conservation of the resource, and hence the highest current public benefits. The uses involved are:

Livestock production estimated at a grazing capacity 50 years hence of at least 17.1 million animal units, instead of the present safe capacity of 10.8 million units.

Watershed services in the delivery of the maximum amount of usable water, with the minimum of erosion, silting, and destructive floods; services which on many areas will constitute the dominant requirement.

The production on forested ranges of timber crops which on the national forests will be one of the dominant uses.

Provision for such part of the rapidly growing need for recreation as the scenic and other facilities of the range country can furnish.

The sustained production of wildlife as a crop.

3. A third group of major problems centers in privately owned range lands and domestic livestock.

(*a*) How relieve private owners of the burden of lands submarginal for such ownership, and of lands on which the cost of maintaining high watershed or other public values is excessive for private holding, and how also prevent the passage of such lands to private ownership in the future.

(*b*) How care for and improve submarginal and high public value lands pending transfer to the public, which may require many years.

(*c*) How obtain a positive recognition of the responsibility of stewardship.

(*d*) How reduce the present 60-percent excess of 6.5 million animal units to what the range as a whole can carry and still improve. Because of livestock ownership the producer is as directly concerned on public lands as on those he holds in fee simple.

(*e*) How place private range lands under satisfactory range management.

(*f*) How restore to the western livestock producer and how maintain his one large competitive advantage of cheap range feed.

(*g*) How aid private owners to acquire economic units which will support a family under reasonable standards of living.

(*h*) How minimize or remove the other existing financial handicaps to economically justified private ownership in inflated land values, unsound credits, unsatisfactory market conditions, etc.

(*i*) How improve existing range animal husbandry.

(*j*) How furnish a reasonable incentive to the private landowner to produce and protect game on his own lands.

4. A fourth group of major problems centers in State and county range lands.

(*a*) How reconcile the need for the conservation of the range resource in the general public interest on Federal land grants with the demand for revenue from these lands by dependent institutions.

(*b*) How provide for the administration and management, for the various purposes for which they are suited, of all State and other public range lands by competent agricultural agencies.

(*c*) How bring order out of chaos in the handling of tax delinquency.

(*d*) How provide for the acquisition of the State's share of submarginal and high public value range lands.

(*e*) How provide for the consolidation of State and county ownerships into efficient administrative units.

(*f*) How carry a long-term constructive program, particularly if it cannot be made self-liquidating.

5. A fifth group of problems centers in Federal range lands.

(*a*) How, since it is a strictly agricultural activity, provide for the handling of the grazing districts by an agricultural agency.

(*b*) How place the remainder of the public domain and other Federal withdrawals and reservations under administration and management.

(*c*) How provide for a sound social and economic distribution of grazing privileges on all Federal lands; probably requiring on grazing districts the modification of organic legislation; and on the national forests, further improvement of administrative policies.

(*d*) How prevent the establishment of prescriptive rights on grazing districts.

(*e*) How prevent a conflict in Federal and State authority in the administration of the grazing districts.

(*f*) How insure an effectively correlated administration of all Federal range lands, and at the same time recognize also the fundamental distinction between the national forests and the more strictly range group of lands. This means providing on the national forests for the necessary further correlation of range use with that of timber and other national-forest resources, and on other lands providing for the further correlation with the resources involved.

(*g*) How provide for the Federal share of the responsibility for acquiring private lands submarginal for such ownership, and lands

with high public values which cannot or will not be safeguarded by private owners.

(*h*) How provide for the consolidation of Federal lands into workable administrative units.

(*i*) How reconcile the existing difference between national forests and grazing districts in the Federal contribution to States, etc., in lieu of taxes and place it on an equitable basis.

(*j*) How provide for an effective working relationship between the Federal Government and the States in the handling of wildlife on Federal lands.

(*k*) How carry a long-term affirmative program, particularly if it cannot be made self-liquidating.

6. A sixth group of major problems centers in the social and economic aspects of integrated range and crop agriculture.

How prevent further human wastage and insure reasonable standards of living and social and economic security for the maximum number of people that the combined range and cropland resource can support. The handling of all lands regardless of ownership is involved.

7. A seventh group of major problems centers in basic knowledge.

(*a*) How obtain the basic information needed by both private and public owners on the biological, social, and economic phases of the conservation and use of the entire range resource.

(*b*) How insure the application of this knowledge by private owners and public-land managers.

In briefest form the lines of action of greatest immediate urgency and importance are—

1. *For the range and soil resource.*—To stop further soil and forage depletion, start both on the upgrade, reduce excessive stocking, and place all range lands under management.

2. *For land ownership and use.*—To rectify existing maladjustments and obtain a sound distribution of ownership between private and various public agencies, build up economic private and public units, balance and integrate crop and range use, and correlate the livestock, watershed, forest, wildlife, and recreation forms of range land uses and services.

3. *For privately owned range lands and livestock.*—To relieve private owners of submarginal and high watershed and other public-value lands, obtain a recognition of the responsibility of stewardship, reduce excessive stocking, place lands under management, restore cheap range feed, build up economic units, and minimize or remove various other financial handicaps.

4. *For State and county lands.*—To reconcile range conservation and the financial needs of State institutions, place lands under administration and management by agricultural agencies, solve the tax delinquency problem, and share the acquisition of submarginal and high public-value lands.

5. *For Federal range lands.*—To transfer the grazing districts to the Department of Agriculture; place all remaining lands under administration and management; to interpret and probably amend the Taylor Grazing Act to provide for a sound distribution of grazing privileges, prevent the establishment of prescriptive rights, and provide for the correlation of various grazing uses; and share the acquisition of submarginal and high public-value lands.

6. *For social and economic security.*—To prevent further human wastage and insure social and economic security for the population dependent on the combined range-cropland resource.

7. *For basic knowledge.*—To obtain and apply the information necessary for the conservation and wise use of the range resource for public betterment.

Implicit in these problems and lines of action is the question of the desirability or necessity, if Federal obligations are to be fully redeemed, for the full concentration of responsibility for public action in a single agency. A similar question holds for the States.

To Restore and Maintain the Range

It is perfectly clear from the preceding discussion that the range resource—the forage and the soil on which it grows—is the key to all forms of use and hence to all the social and economic benefits which should flow from such uses.

The most urgent range resource problems are to stop further deterioration of forage and soil and start both on the upgrade. The ultimate objective is full restoration and permanent maintenance in full productivity. The means which must be employed to accomplish both purposes is to reduce excessive stocking to what the range can carry and improve, and to place all range lands under management.

If the range is to serve its greatest usefulness, plans for stopping deterioration, and for restoration and maintenance, must be formulated around the highest form or forms of use, whether for the grazing of domestic livestock, for the services which watersheds should render, for timber production, for the production of wildlife, or for recreation.

For Livestock Production

One specific indication of the size of the job of halting further deterioration, of restoration, and of maintenance is the 728 million acres of range land which it must cover.

A specific indication of the size of the restoration job is the fact that the present grazing capacity of the range as a whole must be increased by about 110 percent to reach its original condition. Still further, as shown by table 8, restoration must provide for more than 633 million acres now depleted more than one-fourth, nearly 390 million acres more than half, and nearly 120 million acres more than three-fourths.

Table 8.—*The restoration job in terms of areas now depleted*

Depletion classes	Area depleted	
	1,000 acres	Percent
Moderate (26–50 percent)	94,625	13.0
Marked (51–75 percent)	391,697	53.7
Severe (51–75 percent)	275,479	37.1
Extreme (76–100 percent)	117,201	16.2
Total	728,302	100

In briefest form the specific lines of action required are:

1. First and by all odds most important, the reduction of stocking to the actual present grazing capacity. Since present stocking of the entire range area, now 17.3 million animal units, is 60 percent in excess of its estimated capacity, it will have to be reduced by about 6.5 million animal units.

The guiding principle should be stocking year after year with the number of animals which each unit will support each season without injury to the range. The outstanding need for restoration and the wide fluctuations of climate and hence of forage production require conservative stocking for satisfactory results, and this under most conditions should leave from 20 to 30 percent of the palatable growth of the important forage plants during average years. In addition, stocking should be low enough to prevent injury to watersheds and tree growth, and should be properly correlated with wildlife and recreational requirements.

The practical difficulties involved in such reductions are fully recognized, but the owners of private lands and managers of public lands should not overlook the possibility that actual returns will be greater in the long run from conservation than from continued overgrazing. They may be greater immediately. The reduction figures given are for the entire range. Not all ranges and individual holdings are overstocked. Many stockmen who have overstocked free public ranges in self-protection will undoubtedly welcome the opportunity to make reductions to actual grazing capacity when these ranges are placed under administration and the feed for their livestock is assured.

2. A judicious balance for range rehabilitation between natural and artificial revegetation.

The cheapest and most practical method of halting destruction and of restoration on about 635 million acres or 87 percent of the total range areas is through the control of the stocking and the use of sound grazing systems. This means in essence merely giving the native forage a chance to come back under its own marvelous recuperative powers.

On about 38 million acres, or 5 percent, of the most completely depleted areas such as abandoned farm lands and those which are most critical from the standpoint of watershed protection, the choice lies between artificial revegetation, which has a great advantage in time but will cost about $2.85 per acre, and waiting for natural processes, which according to the best information now available would require from about 20 years as a minimum to perhaps 50 years as a maximum.

3. Putting into effect on the ground the best available systems of grazing, including deferred and rotation grazing, continual moderate grazing, and alternate grazing, which are described in more detail elsewhere in the report. The use of these systems is required in both restoration and subsequent maintenance, as are also all of the following lines of action.

Such systems are in effect on about 80 percent of the national-forest ranges, possibly 40 or 45 percent of Indian lands, and 10 to 15 percent of private and State lands.

4. Adjustments of seasons of grazing to safeguard forage plant vigor and prevent damage to the soil.

Such seasonal adjustments have been made on at least 85 percent of the national-forest ranges and seasonal use is probably satisfactory on one-third to one-half of other ownerships.

5. Insuring the use of each range unit by the class of animals for which it is best suited. Where the wrong class of stock is grazed, especial care in stocking and management will be required. On public lands, at least, the proper balance between livestock and game is necessary.

About 80 percent of the national-forest ranges are grazed with the proper class of livestock, but information on other ownerships is not available. This phase of management will be increasingly important as the need for greater efficiency in the use of available forage is recognized.

6. Employment of all practical means such as salt control, water development, herding, and in some cases fencing, to obtain the closest practical approach to even distribution of stock over the range and to reduce livestock handling costs.

Such means are in effect in varying degrees on a rather high percentage of national-forest ranges, on possibly half the private ranges, and on still lower percentages of other ownerships.

7. The preparation and use of practical range management plans, which for most private owners can be very simple. For the private owner, public assistance in their preparation should be made available through extension services.

Serviceable range management plans have been prepared for approximately 82 percent of the national-forest ranges and intensive plans for 48 million acres. Nearly 57 million acres, including intermingled lands, still need range surveys as a prerequisite for fully satisfactory plans. General plans have also been prepared or are in preparation for all Indian range lands, but 28 million acres require range surveys for intensive plans. Nearly 150 million acres of grazing districts and other Federal range lands will need surveys for management plans. Many private owners have sketchy plans for handling their ranges but only a small percentage have developed and applied plans adequate to prevent deterioration and insure rehabilitation of depleted ranges.

8. Animal husbandry is an essential part of the livestock enterprise. Despite rather marked progress, there is still room for improvement. Better practices such as the use of high-quality sires, limited breeding seasons, the culling of aged cows and ewes, supplemental feeding designed to offset mineral deficiencies in range feed, etc., should increase calf and lamb crops, improve the quality of the animals, and increase the prices received. Owners should then be able to obtain the same or greater income from smaller herds and to graze their ranges more conservatively.

FOR WATERSHED PROTECTION

For satisfactory watershed protection, a range service at least equal in value to that for livestock grazing, the following additional provisions are necessary:

1. If some necessary precautions are taken, restoration, and maintenance of plant cover adequate to meet watershed requirements satisfactorily on most ranges is possible under grazing.

2. On approximately 135 million acres of depleted range, according to the best information available, more conservative utilization or greater care in the use of grazing systems, in seasonal use, etc., than that necessary to restore and maintain forage will be required.

3. In some instances, such as seriously eroding areas on the watersheds of important streams, temporary closure to all grazing will be necessary in the public interest. Perhaps 50 million acres may be involved since this will include the 38 million acres requiring artificial revegetation.

4. Small critical range areas, perhaps not to exceed 5 percent of the total range area, will require special erosion-control measures. The exact conditions under which the cheaper and more practical means of natural revegetation must be supplemented by special measures is uncertain, and the most effective measures and what they will cost, are still in an experimental stage.

5. Limited areas, such as municipal watersheds, and those of irrigation reservoirs where the plant cover is on a hair-trigger balance because of adverse conditions, will need to be closed permanently to grazing. A total of about 11.5 million acres fall into this category.

FOR TIMBER PRODUCTION

Included in the range area is about 78 million acres of forest land capable of producing commercial timber crops. Nearly 90 percent is in national forest and private ownership. Under proper management livestock can ordinarily be grazed without jeopardizing the more profitable use for timber growing.

An additional 76 million acres classified as range lands in this report contains forests which will not grow commercial timber products. Here, ordinarily, the choice of dominant use will be between grazing and watershed protection.

FOR WILDLIFE

1. The primary requirement for wildlife is the nearest feasible approach to natural environmental conditions through halting further range deterioration, and through restoration and maintenance. Along with this must go clear-cut recognition of the fact that wildlife is a product of the land and can satisfactorily be produced only as a crop.

2. If properly managed the wildlife resource need not, except on limited areas, conflict seriously with the use of the range for other purposes. For big game animals and waterfowl, exclusive use may be required of only relatively limited areas of range land, in addition to the 2.8 million acres already reserved in the national forests, and areas acquired by the Biological Survey for migratory bird refuges and other wildlife preservation.

3. The strengthening of the basis for cooperation between the Federal Government and the States is a badly needed initial step in the handling of game on Federally owned lands.

4. Beyond this, the development of a coordinated administration of wildlife on all lands regardless of ownership is necessary.

5. The working out of some way to retain hunting and fishing privileges for the average man, which the American sportsman re-

gards as a birthright, is an increasing challenge, as is also some incentive to private landowners to produce and protect game.

6. Other considerations include—

(*a*) Recognition of the need for wildlife management plans and provision for actual preparation.

(*b*) Selection of the personnel in game administration agencies by the merit system rather than by political preference. This necessarily includes the recognition of wildlife management as a profession.

(*c*) Provision for needed refuges and sanctuaries.

(*d*) The ironing out of difficulties in licensing and law enforcement.

(*e*) Provision for the artificial planting of game where needed and feasible.

FOR RECREATION

1. Recognition of the inspirational, social, and economic value of recreation, taking into account its phenomenal recent and probable future growth.

2. Recognition of the fact that range lands have an important recreational function although it is seldom their dominant use.

3. Careful planning, which under most conditions will make possible full recreational use without undue restriction of either livestock use or that by wildlife.

4. Such local adjustments in grazing use as may be necessary.

5. The cash value of recreation in which livestock producers share is an important factor offsetting possible losses. The western "dude ranch" is an example of direct returns, but community returns benefit livestock producers indirectly.

For Private Lands and Livestock

Three hundred seventy-six million acres of western range land is in private ownership. During a few decades, livestock grazing has depleted this area by 51 percent; 85 percent or about 318 million acres is still going down; more than 15 million acres will require artificial revegetation; only about 12 percent or 44 million acres is in good or fairly satisfactory condition.

The magnitude of the private-land problem in area, in estimated present grazing capacity, and in potential grazing capacity 50 years hence, is shown graphically in figure 19 in comparison with public holdings.

The lines of action involving privately owned lands and livestock, which have been designated of greatest immediate urgency and importance in an affirmative program, should be repeated in order to bring the provisions which follow into sharper focus; to relieve private owners of lands which they cannot carry and redeem the responsibilities of stewardship, reverse the process of forage and soil depletion by reducing overstocking and placing all lands under management for their highest forms of use, restore cheap range feed, balance range and cropland use, and to build up economic units and minimize or remove other financial handicaps.

The private ownership of land is so ingrained in our national philosophy that the obvious action called for on range lands is to

afford to private owners the most favorable possible opportunity to hold all lands which are above the submarginal line, or which do not have a special public interest. This more specifically requires combined private and public action to remove or at least to minimize the handicaps which have served to make private ownership precarious under all but the most favorable conditions.

Range lands which, because of low inherent productivity and high ownership costs, are clearly submarginal for private ownership, or which have high public values involving expenditures beyond pri-

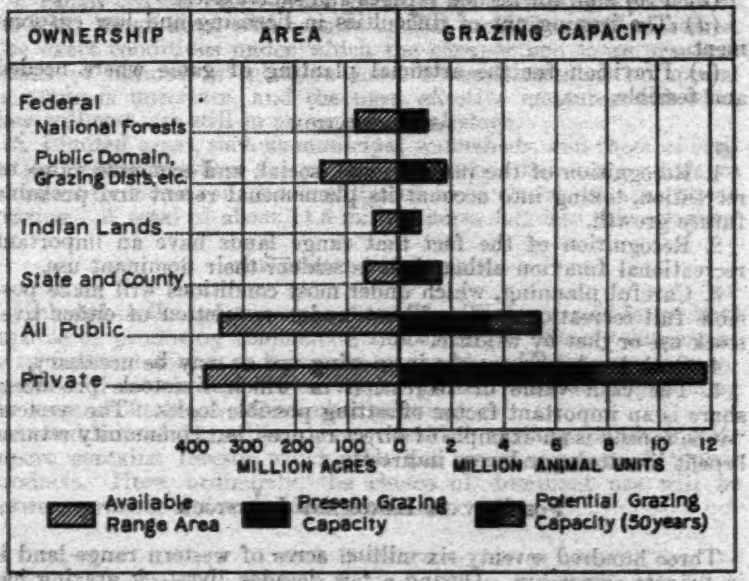


FIGURE 19.—GRAZING CAPACITIES, PRESENT AND POTENTIAL, BY OWNERSHIPS.

Privately owned lands comprise only slightly more than half the range area, but have more than double the present potential grazing capacity of public lands. Such public lands as national forests, the grazing districts, and the public domain are much more important than either acreage or grazing capacity alone indicates, the national forests because of the shortage of summer range and the grazing districts because of the shortage of winter range. Furthermore, these public holdings are the largest areas under single forms of control. Private ownership is not the simple, compact entity that the diagram indicates, but is made up of several hundred thousand ranch, corporate, and other holdings. The transfer of any such area as 125 million acres from private to public ownership will make significant changes in the relationships shown.

vate means fall into an entirely different category. The ways in which private owners may be relieved of the burden of carrying such lands, which total about one-third of those now privately held, are discussed later. Under the most favorable conditions which can now be foreseen, many years will be required for such a transfer. While nominally the following discussion covers the entire area in private ownership, it deals primarily in fact with the lands above the marginal line and without high public value which will remain permanently in such ownership. But it must be recognized that the submarginal and high public value lands will constitute a particularly acute problem prior to transfer.

The universal private ownership of domestic livestock, large numbers of which graze on public lands, broadens the problems of the stockman far beyond his own land holdings and increases the public responsibility for the welfare of the livestock industry.

THE RESPONSIBILITY OF STEWARDSHIP

For reasons already outlined, the private owner's responsibility for the stewardship of land is a concept conspicuous largely by its absence in the United States. Ownership has been regarded as carrying the right of unrestricted use even though it meant destruction and even though the evil consequences of destruction did not stop with the owner but extended to the public and to posterity.

Basic to the restoration and conservation of the range resource is the recognition of an entirely different philosophy: that ownership carries with it the obligation and responsibility for preservation, which the owner owes to himself, to his descendents, and to the public.

Satisfactory recognition and practical application can be obtained only by the fullest cooperation of private and public agencies in such ways as: (1) Local regulatory laws on the use of land; (2) framing and adoption of land policies; (3) land zoning and planning; and (4) various other measures outlined in more detail in the following.

RANGE MANAGEMENT, ANIMAL HUSBANDRY, ETC.

Information is already available on simple practical systems of range management and the handling of stock on open ranges which will permit vast improvement over existing practices, and which should increase the financial returns of the stockman and at the same time restore and perpetuate his basic resource. Although animal-husbandry practices are far in advance of range management on private lands, there is still room for improvement.

Involved are:

1. The recognition of cheap range feed as the outstanding competitive advantage of the western stockman.

2. The recognition of overstocking followed by the necessary reductions, which from the information now available for privately owned ranges as a whole will have to be about 38 percent (figs. 20 and 21).

3. The application of sound systems of management and handling of livestock on the range. This and the preceding should stop depletion and start recovery on the 318 million acres which are still deteriorating.

4. Artificial revegetation on 15 million acres.

5. Water development, fencing, and other improvements, rodent control, etc., as a basis for range improvement and better use of the range.

6. Simple, practical range management plans based on actual conditions—in essence, carefully considered planwise efforts to raise the standards of handling all ranges.

7. Better animal-husbandry practices, such as breeding, culling, supplemental feeding, etc.

The private operator has both an opportunity and an obligation to put such measures into effect individually or through cooperative associations.

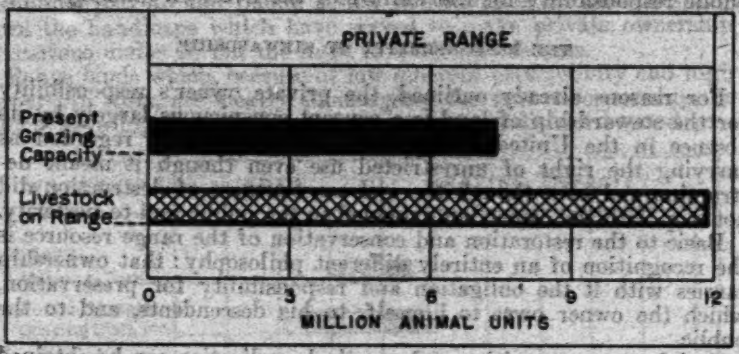


FIGURE 20.—EXCESSIVE STOCKING ON PRIVATE RANGES.

One of the most crucial and immediate problems on privately owned range lands is the reduction of excess stocking, estimated at about 4.5 million animal units. No other single form of action will do more to stop deterioration and start the ranges on the upgrade.

The public can make a large contribution by conducting research and giving advice and assistance through extension agencies in accordance with the plan followed in crop agriculture.

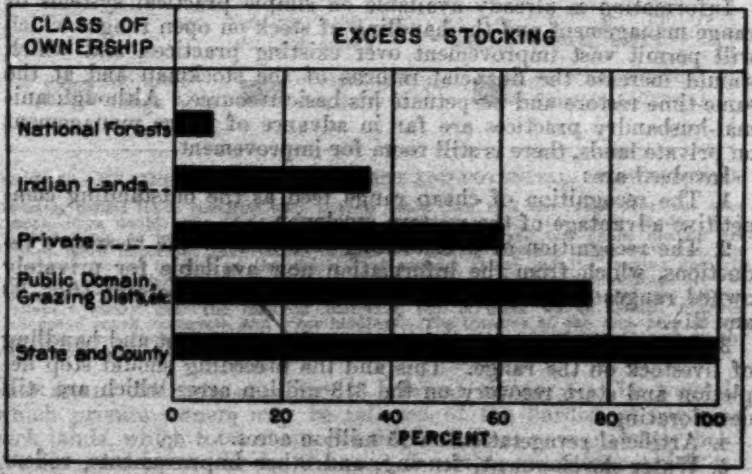


FIGURE 21.—PERCENT OF EXCESS STOCKING BY OWNERSHIPS.

Except on the national forests, the removal of excess stock is a critical problem. Even on the national forests, where the excess is relatively small, the problem will be difficult.

Where large cash outlays are required for revegetation, erosion control, range improvements, etc., public assistance might take the form of doing a part of the work or of subsidies provided, in view

of the recent A. A. A. Supreme Court decision, they can be made conditional upon requirements for improved range practices, or provided some other effective means can be worked out.

The Soil Conservation and Domestic Allotment Act may provide a means for aiding both private and public owners to restore and maintain the soil and range resource. Any payments to private owners or tenants, or to the permittees on public ranges, which may be made under this act, should among other things be conditional upon livestock reductions to the grazing capacity of the range, and upon such other requirements as satisfactory systems of range management, proper seasonal use, etc.

Among the responsibilities of stewardship carried with private ownership of land is watershed protection. The major part of watershed responsibilities for especially hazardous conditions must, however, be borne by the public.

About 25 million acres of privately owned forest land capable of growing commercial timber is valuable also and available for grazing. On such lands higher returns can ordinarily be obtained from timber growing, and consequently it will be in the self-interest of the owner to make timber growing the dominant purpose of management. Timber returns can usually, however, be supplemented by those from livestock grazing.

For the production of game some form of compensation to the private owner will be necessary, either by sportsmen's associations or the States. Precedents exist in several States.

RECONSTRUCTION OF ECONOMIC UNITS

As a result of factors already discussed, including unsuitable land policies, large numbers of land units in the West are uneconomic from the standpoint of supporting families under reasonable standards of living, and hence socially undesirable. Such units fall into three classes: (1) Undersized cash-crop livestock units; (2) undersized livestock units; (3) oversized livestock units.

Sound economic units will vary within wide limits because of radically different regional and local conditions and the differences in individual enterprises. The formulation of guiding principles for working out such units constitutes an exceedingly complex and difficult problem, and the application will be even more difficult and time consuming.

The tendency already begun to build units up to economic size should be encouraged. Provision will have to be made, however, for the resettlement on irrigation projects or otherwise of people who are eliminated.

The tendency for oversized units to break down should be encouraged and this should help to take care of excess population eliminated in building up small units.

The size of satisfactory units may under some conditions be held down by a greater diversification of crops and at the same time a more stable agriculture assured. The building up of range productivity should also be a factor in holding down the size of satisfactory range units.

The addition to the already large area of public range land of about one-third of the land now privately held will accentuate the

place which the use of public lands must fill in economic units. The availability of public lands will reduce the size for private units. It must be recognized, however, that the total area of range land is not large enough to meet all requirements, that practically all ranges are already badly overstocked, and that the soundest use of public range will be to build up economic units and not to perpetuate uneconomic units.

The availability of public ranges on the national forests, grazing districts, and State lands should afford an opportunity for labor to supplement income and hence to reduce the size of private units which would otherwise be necessary.

Despite the fact that up to the present economic units have not insured satisfactory handling of the range, they do, theoretically at least, constitute an essential basis for stabilizing private ownership and insuring economic security, and should accordingly receive corresponding attention.

INFLATED LAND VALUES

Both owners and their creditors must be prepared to accept deflation of range-land prices to actual values, and public agencies can render material aid by placing credit on a sound basis. Authoritative information on values, obtained by research, should be invaluable as a guide.

PRODUCTION CONTROL

The excess of annual exports over imports in "meat and meat products" dropped by more than 80 percent, to $49,000,000, between the 4-year period ending June 30, 1926, and that ending June 30, 1935. Net imports of "wool and mohair" decreased by nearly 90 percent, to $15,000,000 for the same periods.

These changes reflect both a decreasing export market and changing requirements at home. Stockmen no longer have the advantage of a continuously expanding domestic market.

Manufacturers can rather easily restrict their output to demands, but because of the nature of the enterprise similar action by livestock producers is much more difficult. Some means of avoiding unmanageable surpluses will undoubtedly be desirable in the interest of the producer and consumer alike.

MARKETS

To overcome marketing handicaps producers have in their own hands such means as cooperative associations and the uniform grading of their products. The public can continue to assist by encouraging cooperative marketing; by studying such questions as distribution, marketing differentials, the demands of the trade, etc., and making the information available; and by preventing combinations in restraint of trade and unfair practices prejudicial to the livestock producer.

CREDIT

The prime needs in the credit situation are to adapt credits to the requirements of the livestock industry, as to period of loans and

rate of interest, to base loans on the productivity of both the range resource and livestock as collateral, and to couple with loans the requirement that the range resource be maintained.

More favorable and satisfactory public credit facilities are rapidly being developed under the Farm Credit Administration.

TAXATION

Much more exact information is required before any great improvement in the taxation system can be expected. While the task of obtaining such information is a public obligation, the livestock industry can encourage such undertakings.

RESEARCH AND EXTENSION

Both research and extension are primarily public responsibilities, but should be encouraged by the livestock interests. The program needed is outlined hereafter.

IN PUBLIC LAND ADMINISTRATION

Exclusive of that proposed for Federal and State acquisition, the areas of publicly owned or controlled range land with which the following program deals are summarized in table 4.

TABLE 4.—*Area of publicly owned range lands*

Ownership or control	Range area	Available range
	Acres	*Acres*
Federal:		
National forests		
Grazing districts	[1]	[2]
Public domain		
Other		
Indian lands		
State, county, etc.		

[1] Gross area.
[2] Also total range area.

Here again, despite repetition, the action of greatest immediate urgency and importance should be restated in order to obtain the proper emphasis on the various provisions of the public range land program proposed: To transfer jurisdiction to agricultural agencies in order to obtain effective correlation and administration; place all remaining lands under administration in order to reduce excessive stocking, get ranges under management, and reverse forage and soil depletion processes; in administration and management, to follow the multiple-use principle, obtain a sound distribution of the grazing privilege, and avoid prescriptive rights; consolidate holdings into efficient administrative units; relieve private owners of the lands they cannot carry, by purchase or acceptance of gifts; rectify the chaotic tax-delinquency situation; and use public lands as an affirmative means to social and economic security.

FEDERAL RANGE LAND JURISDICTION

One of the most urgent problems confronting the administration of the Federal range lands is that of jurisdiction. The 82.5 million acres of available range in the national forests is administered by the Forest Service in the Department of Agriculture, but the 60.6 million acres already in grazing districts is administered by the Grazing Division in the Department of the Interior. The latter Department is also responsible for the 67.2 million acres in the public domain which have not been placed under administration.

Some fundamental differences in national forest, and grazing district and public-domain lands, as well as some fundamental similarities, must be recognized. The national forests contain important timber, watershed, wildlife, and recreational resources which are intermingled with and cannot be segregated from the range resource.

The grazing districts, the public domain, and various other unmanaged Federal withdrawals are largely arid or semiarid lands valuable primarily for grazing, but in part having very high watershed values and also values for wildlife and recreation.

Because of the fundamental differences, the territorial integrity of both classes of units should be maintained. But some boundary adjustments are needed to place in each the resources it is designed primarily to conserve, to round out natural topographic units, and to simplify administration.

Because of the fundamental similarities, the range administration of both classes must be closely correlated. Both must be integrated with ranch and farm lands, and in many cases with the same lands. Large numbers of livestock, and game in some instances, are dependent on the national forests for summer range and the grazing districts for winter range. The grazing districts can relieve the shortage of spring-fall range on the national forests. Some range improvements can serve both classes of land. Both can benefit by an interchange of supervisory and technical services and information.

Having to deal with two entirely distinct personnel groups in two Departments on different phases of a single problem creates an impossible situation for the user. Policies, procedure, legislation, point of view, and basic theories which should be consistent are bound to differ.

Practical experience shows conclusively that misunderstandings, conflicts, and jurisdictional disputes, all of which reduce efficiency and public service, are bound to arise. Stockmen are placed in a position in which the easiest way out may seem to be to play one department against the other, often to their own detriment and that of the resource.

Finally the ultimate cost to the public of separate departmental jurisdiction, assuming thoroughly efficient administration, and taking duplication of effort and field and overhead organizations, etc., into account, will certainly be higher. In short, there seems to be no justification whatever for splitting jurisdiction between two departments.

A decision on the most logical and effective jurisdiction should take the following factors into account:

The management of range and also of forest lands is agriculture pure and simple. It deals with the soil, the interrelation of soil and plant cover, water and climate, with plants and animals, the diseases and insects affecting both, with the maintenance of biological balances between plant and animal life, with the growing and harvesting or utilization of crops, in fact, with all of the "problems relating to the growth from the soil." It deals with the economic and social as well as the biological problems of land use in all of their phases. It must rest upon the biological and economic sciences which have to do with soil, water, climate, plants, animals, and land.

The forage on public ranges is used by livestock from the farms and ranches, which are fed increasingly on farm forage crops. Western crops are largely dependent on irrigation water from forest and range watersheds. The use of the public range and forest land and private range and farm land is interrelated in innumerable other ways.

The Department of Agriculture, as one of its major projects, is attempting to meet the Federal obligation to help agriculture develop a sound program. In this undertaking the problems of the public range and forest lands cannot be separated from those of other range and crop lands.

Nearly all the Federal bureaus charged with research and administration relating directly and vitally to forestry and range management and to the development of a land-use program are in the Department of Agriculture (fig. 84). It is the duly constituted and authorized Federal agency for dealing with the agriculturist. It works in close cooperation with the State agricultural colleges, experiment stations, and extension services.

The Department of Agriculture is, therefore, the logical and, in fact, the only well-equipped department for the administration of federally owned range and forest lands.

PRINCIPLES OF ADMINISTRATION

The principles which should govern the administration of all federally owned range lands, whether on the national forests or the grazing districts, including the public domain and other Federal withdrawals and reservations, are:

1. Management which will restore and maintain in perpetuity on a sustained yield basis, and utilize, all of the resources of the land.
2. The correlated use of all the resources to obtain the highest net public benefits.
3. The integration of the public-range resources with privately owned crop and range lands to obtain the highest benefits from all of the lands locally, regionally, and nationally.
4. An equitable distribution of the grazing privilege, based on the highest net public benefits, to those who are dependent upon and are entitled to use the range.
5. Readjustments of land ownership and use where needed and justified to facilitate economical and efficient management and administration of public range lands.
6. A decentralized administration qualified to settle local problems in accordance with local requirements, and responsive to the advice

and assistance of local users to the extent consistent with the protection of the public interest—the antithesis of bureaucracy.

The application of these principles requires a far greater development of research than has hitherto been possible, and the prompt and full use of the findings. The purpose of enhancing private opportunity on lands suitable for such ownership, and the still broader purpose of insuring the greatest possible social and economic stability of the dependent agricultural and other population, must underlie the entire administration of the public range resource.

NATIONAL FORESTS

The principles outlined, with occasional minor modifications to meet conditions, have been the basis for national forest administration for many years. The chief tasks of the future are:

1. A reduction in stocking averaging 6.5 percent to reach the present grazing capacity of the range (fig. 21). Restoration during the next 50 years should make it possible for these ranges to carry 20 percent more stock than the present grazing capacity of the range.
2. A strengthening of range management; including the preparation and use of intensive management plans on the 40 million acres not now so covered and periodical revision when necessary; seasonal adjustments not satisfactorily solved on about 12 percent of range allotments; reseeding of about 780,000 acres; other special treatment for sore spots; improvements such as water developments and fencing, rodent control, etc.
3. Improvement in the basis for the distribution of the grazing privileges to insure a more effective tie with privately owned lands and to afford greater security to the small private operation dependent on and entitled to use public ranges.
4. Occasional changes for a better correlation of range uses.

Approximately half, or 43 million acres, of the national forest range area is forest land capable of producing commercial timber. On such lands timber production will have to be the dominant use because of the provisions of organic legislation and the general purposes for which the national forests were created. Grazing use will generally be possible but will have to be made contingent upon the protection of forest growth and continuous forest production.

About 22 million acres additional is noncommercial forest in which the correlation required will be between livestock grazing and watershed protection.

Since organic national forest legislation provides for "maintaining favorable conditions of water flow" the handling of livestock grazing must insure watershed protection. On relatively limited areas special erosion-control measures are required.

GRAZING DISTRICTS, PUBLIC DOMAIN, AND OTHER FEDERAL

Practically the entire problem of placing the grazing districts and public domain under management lies ahead. The complexity and difficulty of the task is accentuated by the existing depletion of nearly 70 percent, by the fact that 93 percent is still on the down grade, by long-established traditions of use, by an extremely involved

ownership pattern in some regions, and by private holdings of key areas in others.

To carry out such an essential measure as placing the remaining half of the public domain under administration and to insure permanence will require the modification of existing legislation.

To carry out other essential measures—such as an equitable distribution of grazing privileges; the reduction of stocking, which now exceeds grazing capacity by 43 percent (fig. 21), to insure coordinated use of all the range resources; to avoid the establishment of prescriptive rights; and to avoid a conflict between Federal and State authority—will require exceptionally favorable interpretation of the Grazing Act in the public interest, and probably also its modification.

In addition to the reduction of stocking, essentials in the field of technical management include putting sound systems of range management into effect, making adjustments in seasonal use, artificial restoration on at least 18 million acres, the control of erosion on many millions of acres, surveys, preparation and putting management plans into effect for the entire area, and a large improvement program designed to aid technical management.

The measures proposed should increase the present grazing capacity of the grazing district-public domain range by 76 percent in 50 years. Or putting it in another way, 50 years' effort will be necessary to build the range up to the point where it can carry safely the livestock now being grazed.

Some provision should be made for the administration and management of the 21.6 million acres of available range on other reservations and withdrawals, preferably by the Secretary of Agriculture with the concurrence of the Secretary of primary jurisdiction.

Definite provision is necessary also to prevent further alienation of Federal lands unsuitable for private ownership. One prerequisite for transfer should be classification by the Department of Agriculture, which should appraise not only the suitability of the land for private ownership but also the size of the unit required.

INDIAN LANDS

The primary objective in range management on 48 million acres of Indian owned but federally controlled range land is the social and economic advancement and security of the Indians.

The major and most pressing task is the rehabilitation of depleted ranges. For all Indian lands an estimated reduction in stocking averaging 26 percent is required to reach grazing capacity (fig. 21), and a still higher reduction is necessary on the half of the Indian grazing land in the Southwest where the depletion is worst.

This is a difficult situation, for unless depletion is stopped the Indians face ruin through the loss of one of their most important resources, but drastic livestock reductions will create another difficult problem. Removal of white-owned livestock, more equitable distribution of grazing privileges among the Indians, the purchase of additional range, the initiation of work projects, and the development of supplemental industries are possible shock absorbers.

Reductions in stocking must be accompanied by other improvements in range management, removal of worthless horses, rodent control, special erosion control, and artificial revegetation.

The consummation of the program proposed will, it is estimated, permit the grazing of about 13 percent more livestock 50 years hence than are now grazed.

STATE AND COUNTY LANDS

State and county range lands, aggregating some 66 million acres, fall into two general classes.

The first is the remnant of Federal grants to States designed to produce revenue for schools and other institutions. In the main these lands have been leased without control to obtain maximum current revenue and as a result have been depleted by 49 percent, and 88 percent of the total area is still on the downgrade.

The difficulty of the problem that the States face in these lands should not be minimized. The policy so far followed will ultimately defeat the purpose of the grants unless ways and means are developed to restore and conserve the resources which give the lands their value. In some instances already the ranges have been depreciated so far that they can no longer be leased. While constitutional and other limitations have been a factor, the very fact that these lands have not already been sold is an indication that a substantial part is submarginal for private ownership and should be retained by the public.

The other horn of the dilemma is that the State institutions are dependent in varying degree upon the receipts, and the range cannot be restored and administered without expenditures which may equal the receipts. The soundest course in the long run will probably be to restore and maintain the resource, making what other provision may be necessary for the institutions.

The second class is made up of private lands which have reverted to the States or counties through tax delinquency. That the total area is large is certain, but its exact extent is unknown. Much tax-delinquent land is still in a twilight zone between private and public ownership. Without doubt submarginality for private ownership is a primary cause. Depletion is also a primary cause because it has reduced the productive capacity of the lands and hence the returns from them. The combined depression and drought has hit hardest the poor and depleted lands and uneconomic units.

To meet the increasingly serious problem created by this "new public domain" a revolutionary change in policy in most if not all States is required. Only those lands above the marginal line on which the private owner has a chance for success, and those without high public values, should be returned to private ownership. Those below and those with high public values should be retained under public control. A differentiation can be worked out by such means as classification or zoning. On tax-reverted lands the problems of restoration and management are identical with those on institutional lands.

Except for possible minor modifications the principles which should govern management and administration are the same as those for Federal lands. A primary consideration will necessarily have

to be, as for Federal lands, the placing of responsibility for a purely agricultural function in agricultural agencies. Widely scattered small units will require consolidations through exchanges or otherwise. Stocking should be reduced to what the range can safely carry (fig. 21). State and Federal cooperation may be helpful in some instances.

PUBLIC ACQUISITION

A program has been outlined, having as its objective the keeping of private ownership as fully in the range picture as reasonable financial returns permit, by the removal of existing handicaps and the solution of existing problems.

The swing from public to private ownership has gone so far, however, that the maximum feasible self-help by private owners supplemented by everything that the public can reasonably be expected to contribute will still leave a major problem on a part of the 376 million acres of range land now privately owned. The classes of land involved are:

1. Approximately 15 million acres of range land on which the dry-farming effort has clearly failed, and on which private ownership now seems to be at the end of its rope. Failure has led to tax delinquency, abandonment, excessive relief rolls, and a long train of other adverse social and economic consequences. Unless artificial revegetation costing from $3 to $3.50 per acre is resorted to, natural processes will not restore the forage cover for years or even decades. The cost of revegetation or the alternative of protracted holding of unproductive land are both beyond the capacity of the private owner. Some other constructive action is therefore called for on what was, and is potentially, some of the best or most needed western range.

2. Range lands submarginal for private ownership, because of low or uncertain forage productivity, excessive depletion and slow recovery, high ownership costs such as investments required, improvements, taxes, etc. Low productivity and high costs are both accentuated by marketing costs, which are very high for all of the far western range States except California, in comparison with those of the Middle Western States. Taking all factors into account, the tall-grass prairies and the short-grass plains east of the Rockies offer the most favorable opportunities for private ownership, and the salt-desert shrub and southern desert shrub of the Intermountain and Southwest regions the least favorable. The best approximation which can now be made places 113 million acres of this category in the problem class.

3. Coinciding closely with the submarginal land area is a large area of range lands having high public values for watershed protection. The constructive management of these lands is a critical watershed problem, and because of the cost of the range restoration, restricted grazing, and other special erosion-control measures required, from many of which the public rather than the private owner will benefit, it is difficult if not impossible to hold them under private ownership. The total area of such watershed lands is about 118 million acres. It includes about 107 million acres of more or less seriously eroding land contributing silt to important western streams.

4. In the high public-value class are also about 6 million acres of privately owned range land needed in part for wildlife. These areas are widely scattered and are required to provide for such specific wildlife needs as winter ranges for deer and elk herds which summer in the national forests. These areas fall almost entirely within the two preceding classes.

5. Within and adjacent to the national forests are about 18.9 million acres of private range land, in part forested, which are needed to round out administrative units or for other administrative purposes and which should be acquired by the Federal Government. Some of these lands are probably also submarginal for private ownership.

Except for a small part of the land area discussed above, justification for public ownership depends upon more than one consideration. Submarginality for the greater part of the area is, for example, accentuated by high public watershed values. After making the necessary adjustments for the overlapping of the various classes, the area which should be taken over by the public totals on a very conservative basis about 125 million acres, or one-third of the range land now in private ownership.

Outright subsidies to hold submarginal and special public-interest lands in private ownership are very difficult to justify. For much of the area involved they would constitute a perpetual drain on the public treasuries, and for the private owner would merely postpone the day of final reckoning. Other possible alternatives which should be considered for the solution of this problem are very limited.

Legal regulation of private range lands, and particularly those of the classes described, encounters the difficulty that improvements in land conditions through better husbandry would cost money, while even with past husbandry the cards have been stacked against the private owner. Furthermore, regulation would be seriously handicapped unless it were supported by the large majority of owners, which is far from being the case.

The only additional alternatives seem to be public acquisition of the land by tax delinquency, by gift, or by purchase.

Although the record of both Federal and State management of range lands is spotty, the possibilities of constructive management have been shown on the national forests and some progress has been made on Indian lands. Even without the suggested acquisition program both the Federal Government and the States have large unsolved problems of range administration.

Since public acquisition in one form or another strikes directly at the problems of what to do with lands submarginal for private ownership and of those having high public values, it seems the only possible course, despite the problems for which public agencies still have to redeem their responsibilities, the long time which will be required for the consummation of the program, and the cost.

Acquisition by tax delinquency means letting the situation work itself out gradually through the play of economic forces. This plan has obvious advantages, and regardless of other action will have a place in the solution, but against the advantages must be weighed further depletion of the range resource, losses from the lack of watershed protection, and even more important, an appalling human wastage.

It is quite possible that considerable areas might be given outright to either the Federal Government or the States if the way were paved. Further inducements might be authority to pay an equitable proportion of accrued taxes, or the privilege of free use of the range under proper control for a limited number of years.

For much of the area, however, the only recourse will probably be outright purchase.

The transfer of large areas to Federal ownership will require suitable provision for payments to States and counties in lieu of taxes. Similar provision for counties will be necessary for lands acquired by the States.

This report is a first attempt to appraise the nature and extent of the various widespread and apparent fundamental maladjustments in ownership and in the kind of use of range lands and the remedies for them. The conclusions on the desirable or required shifts in ownership are necessarily approximations. A large amount of detailed study covering the entire range territory will be required to work out exact areas, locations, etc. Such detailed work is essential also to determine an equitable division of responsibility between the States and the Federal Government for which the data now available does not justify even an approximation.

One thing is clear, that the job of range-land acquisition is large and that it is essential in the public interest. A reasonable start is justified, even though the size of the job is not known with accuracy and though a division between the States and the Federal Government remains to be worked out. Since both public action and inaction have helped to create the problem, it is clearly up to the public to initiate efforts for its solution.

In Research and Extension

Lack of knowledge, the inevitable outcome of the belated beginning of research and the small scale on which it has been conducted, has been one of the most important contributing factors to rule-of-thumb management of the range, and hence to practically universal range depletion and to the social and economic maladjustments and losses which have resulted. It is partly responsible for allowing problems inherently difficult to drift until they have become so acute that drastic remedial action is imperative to save a great natural resource and the population that is based on it. The high cost of the program of rehabilitation is in part the price which must now be paid for a lack of knowledge. And ironically, the knowledge must still in the main be acquired.

The only alternative choice to the long, slow, costly, and inconclusive working out of large-scale trial and error in acquiring knowledge is research. Research, in fact, offers the cheapest and the only practical basis for obtaining the information needed to bring about the fullest productive use of range lands for livestock grazing, watershed protection, forest growth, recreation, and wildlife, and for a sound correlation of these uses.

Research and the effort necessary to carry the results into application are needed by private owners and equally by the administrators of public lands. They offer one of the most effective forms of public aid to the private owner.

The major lines of research required are:

1. Range management, to improve existing systems or to develop new systems for handling each of the range types, and covering also degree of stocking, seasonal use, class of stock, methods of handling livestock under range conditions, restoration by natural revegetation and subsequent maintenance in a high state of productivity. It must include all forms of use and service.

Basic to range management is the need for detailed information on the characteristics, habits, requirements, value, etc., of individual range plants; and also information on the characteristics, behavior, competitive relationships, succession, soil, and other requirements, etc., of the associations of range plants which form types.

2. Artificial revegetation, to develop quick, low-cost reseeding and transplanting methods of restoring vegetation on the depleted ranges for grazing and watershed and other purposes. For artificial revegetation there is also the need to develop improved strains of range plants or hybrids, and also to explore the possibility of foreign introductions.

3. Watershed investigations, to determine methods of managing the plant cover of range watersheds to prevent erosion, silting, and floods, and assure the maximum supply of usable water. This involves a clear understanding of the part that the cover in varying degrees of composition, density, etc., and under different soil, topographic, climatic, grazing, and other conditions plays in erosion and run-off. Practical special-control measures should also be developed for use in arresting aggravated erosion as a preliminary to the reestablishment of plant cover.

4. Wildlife, to develop basic principles and methods for restoring environmental conditions and for managing the wildlife resource as a crop, both in proper relation to other products and services of wild lands. This necessitates also a full understanding of the life histories, requirements, etc., of the wildlife species.

5. Animal husbandry, to improve or develop livestock strains especially adapted to range conditions and to market requirements, and also better breeding and feeding methods.

6. Economics, to determine the proper place of western range livestock production in the local, regional, and national picture; the most effective integration of range and crop agriculture; costs, returns, profits, and other information needed for the determination of satisfactory economic units and for the efficient handling of individual enterprises; a sound basis for the highest use of range land for grazing or other purposes; a sound allocation between private and public ownership and between the States and the Federal Government; the basis needed for policies and administration of public lands; and, in general, the basis for sound land use and for social and economic security.

7. Additional investigations needed include climate, entomology, etc.

The range research so far done will permit vast improvements over nearly all existing practices so that there is no need for delaying initial action on a constructive program. For the full consummation of the program recommended, however, it is only a meager beginning.

The responsibility for range research rests with—

The Federal Government for work on interstate, regional, and national problems, and on local problems for the administration of Federally owned or controlled lands.

The States for work on local and State problems and on other problems where the administration of State lands or those of minor political subdivisions are concerned.

Endowed institutions have the opportunity for work on a wide range of problems, and particularly those of a fundamental character.

Private agencies, and associations in particular, have the opportunity to round out and supplement the work which other agencies can do.

Past experience has shown that the most effective application of the results of agricultural research can be obtained through extension. In the range-animal husbandry field extension activities have been partly responsible for marked improvements, but extension in range management has been almost wholly neglected. Provision for research fails in its real objective unless its results are made known through extension in such a way that they can be applied by the private owner. An essential feature is aid and advice in the preparation and carrying out of sound management plans.

In Legislation

Both Federal and State legislation will be required to carry out the program recommended. The more important provisions are:

FEDERAL

PUBLIC DOMAIN AND GRAZING DISTRICTS

1. To transfer jurisdiction of the public domain and the grazing districts from the Department of the Interior to the Department of Agriculture.

2. Necessary or desirable modifications of the Grazing Act of June 28, 1934:

To place all of the public domain under permanent Federal management.

To prevent the establishment of prescriptive rights.

To allow the distribution of grazing privileges necessary for both social and economic security to the greatest number entitled to use the range.

To authorize administration of all range resources, forage, watershed, wildlife, in accordance with the multiple-use principle and for the highest public benefits.

To clarify Federal authority in the administration of its own lands.

To authorize the leasing of isolated tracts of Federal lands of less than 640 acres.

To authorize the President, upon the recommendation of the National Forest Reservation Commission, to transfer to the national forests from the public domain or the grazing districts lands which in the judgment of the Secretary of Agriculture meet national-forest specifications.

3. Unless fully authorized, as on the Indian reservations, to provide for the administration of ranges on all other Federal reservations and withdrawals, where not inconsistent with their purposes, by the Secretary of Agriculture with the concurrence of the Secretary of primary jurisdiction.

THE TRANSFER OF PRIVATE LANDS TO FEDERAL OWNERSHIP

1. To authorize the Secretary of Agriculture to transfer to national forests or grazing districts, lands purchased by Federal agencies, if they meet the qualifications for such units.

2. To authorize the Secretary of Agriculture to purchase range lands submarginal for private ownership or needed for public benefits such as watershed protection, upon approval of the National Forest Reservation Commission, and to add them to national forests or grazing districts.

3. To broaden existing authority so that the Secretary of Agriculture could make exchanges with private or other public owners within or adjacent to national forests or grazing districts on the basis of equal land or grazing values, in order to consolidate ownerships for more efficient administration, and also to pay costs of transfer and an equitable part of unpaid taxes on donated lands.

TRANSFERS TO PRIVATE OWNERSHIP

To provide for the classification by the Secretary of Agriculture of Federal lands in the public domain as most suitable for private ownership, as a prerequisite for alienation, coupled with other provisions as to maximum size of units, etc., which will prevent a repetition of the mistakes of the past. More study will be necessary to afford a satisfactory basis for such legislation.

EXTENSION

To provide for aid to private owners through extension in cooperation with State agencies.

STATE

Legislation which will substitute for sale or other disposal to private owners the retention and sustained yield management of range lands now in State ownership or which may hereafter be acquired, which are unsuitable for private ownership. This will include:

1. Possible revision of State constitutions and Federal enabling legislation.

2. The setting up of professionally qualified administrative agencies.

3. The revision where necessary of tax-delinquency legislation.

4. Provision for consolidations through exchanges with private owners and the Federal Government.

5. Provision for classification by competent agricultural agencies as a prerequisite to passage to private ownership.

6. Provision for cooperation with the Federal Government on the administration of intermingled holdings.

7. Provision for the acquisition by gift or purchase and management of lands submarginal for private ownership or having high public values.

8. Provision for cooperative aid to private owners of range land, in research and extension.

9. Authority to form cooperative range management associations.

10. Provision for the handling of wildlife: On a sustained crop-management basis; with professionally trained organizations; under flexible laws which outline principles but delegate authority to make adjustments in administration necessary to meet rapidly changing conditions; in cooperation with the Federal Government on Federal lands; some reasonable incentive to private owners to protect and produce wildlife on their lands.

Costs and Returns

The cost of carrying out any such constructive program as that outlined for 728 million acres of range land will be high. Unfortunately, postponement will only increase the final cost, because the longer the destructive forces now in effect continue the more the ground that must be regained. The cost will fall upon the Federal Government, the States, and private owners.

The following estimates of cost are based on 30 years' experience in the handling of the national forests and on special surveys conducted on the public domain and on privately owned lands. The estimates are for the amounts believed necessary to carry out the program recommended. In the light of extended national forest experience in which the rebuilding of the range resource has been retarded by inadequate funds, it is not believed that the public ranges, at least, can be restored and maintained for less than the amounts stated. The estimates are given because of the conviction that the public should have a full understanding of probable costs before embarking on a much larger enterprise than that now under way. No estimates have been made for special erosion control because of uncertainty as to the area which should receive special treatment other than revegetation, and what such treatment would cost. Special treatments are still in an early developmental stage.

The proposed expenditures fall into four categories—capital investments in improvements, current expenditures for administration, the public acquisition of land, and research and extension.

NATIONAL FORESTS

Annual costs first 5-year period

Capital investments, including range surveys, fences, water development, revegetation, rodent control, etc.	$1,140,000
Grazing administration on 82.5 million acres at $0.0149 per acre (present cost $0.0089 per acre or $734,000)	1,234,000
Wildlife administration on 120 million acres at $0.006 per acre (present cost $0.0018 per acre or $216,000)	720,000
Maintenance and replacement of improvements	742,000
Total annual cost	3,836,000

For the second 5-year period annual expenditures for capital investments would be reduced to $910,000 and for the maintenance and

replacement of improvements increased to $986,000, making the total annual cost $3,850,000.

GRAZING DISTRICTS, PUBLIC DOMAIN, AND OTHER FEDERAL

Annual costs first 5-year period

Capital investments, chiefly revegetation, 149.4 million acres	$3,536,000
Grazing administration at $0.0151 per acre	2,260,000
Wildlife administration at $0.001 per acre	150,000
Total annual cost	5,946,000

For the second 5-year period annual expenditures for capital investments would be reduced to $3,403,000, and for maintenance and replacement of improvements would amount to $550,000, so that the total annual cost would be $6,363,000.

INDIAN LANDS

Annual costs first 5-year period

Capital investments, 48.4 million acres	$766,000
Grazing administration, at $0.011 per acre (present cost $0.005 per acre, or $242,000)	532,000
Wildlife administration, at $0.001 per acre	48,000
Maintenance and replacement of improvements	75,000
Total annual cost	1,421,000

For the second 5-year period annual expenditures for capital investments would be reduced to $532,000, and for maintenance and replacement of improvements would be increased to $232,000, so that the total annual cost would be $1,344,000.

STATE AND COUNTY LANDS

Annual costs first 5-year period

Capital investments, 65 million acres	$1,313,000
Administration (minimum)	754,000
Total annual cost	2,067,000

During the second 5-year period, maintenance and replacement of improvements would probably cost about $150,000 annually, making the total annual cost $2,217,000.

PRIVATE LANDS

The annual capital investments needed during the first 10-year period on the 376 million acres now in private ownership is estimated at $6,416,000, of which the largest item is about $4,800,000 for revegetation. Incidental labor will take care of a substantial part of this cost, and furthermore it will be reduced by the rate and extent that the public assumes the burden through acquisition of the poorer private lands where costs of restoration, etc., would be highest.

PUBLIC ACQUISITION OF PRIVATE LANDS

The acquisition of 125 million acres of submarginal watershed and other high public-value land would require at least 20 years. Taking into account gifts with or without payment of accrued taxes, tax delinquency, and direct purchase, the cost might average $1 per acre, or about $6,300,000 annually.

The annual cost of public administration is estimated at about $0.015 per acre, to which should be added capital investments of about $0.017 per acre annually during the first 10 years. The rate at which total annual costs build up will be governed by the speed of acquisition. The latter figures duplicate estimates already given and will correspondingly reduce the expenditures by private owners.

The Federal and State shares of these costs will obviously depend upon the division of the areas acquired between these agencies.

RESEARCH AND EXTENSION

To meet the requirements for all classes of range research it is estimated that expenditures by all agencies should reach an annual total of $2,750,000 in a 10-year period, this by gradual increases over current expenditures of about $750,000. Of the former total the Federal Government should assume the responsibility for about $2,000,000 and the States for $550,000, leaving a $200,000 balance for other agencies.

The cost of range extension estimated at $1,000,000 annually should be borne about equally by the Federal Government and the States. The estimated maximum cost should, if possible, be reached in about 10 years.

RETURNS

The high cost of rehabilitation and administration of publicly owned range lands makes the possibility of self-liquidation a question of both public and private interest.

Looking ahead, it is doubtful if the Federal Government can any more than break even on any comprehensive program of range restoration and intensive management on the national forests and the grazing districts, even though grazing fees on the national forests were ultimately increased by about 30 percent above the base fees, and those on the grazing districts were made approximately equal to the national forest base fees.

Even then, account is taken neither of the uncertain cost of special erosion-control measures nor of Federal contributions to States and counties in lieu of taxes, which in a sense are the transfer of funds from one public purse to another.

Grazing fees high enough on both the national forests and the grazing districts to enable the Federal Government to break approximately even seem fully justified. Fully productive, well-managed ranges should result in higher returns to the stockmen and justify somewhat higher fees than those now charged on the national forests and those apparently contemplated for the grazing districts.

Sight should not be lost of the fact, however, that the public receives other tangible and intangible benefits from fully produc-

tive ranges. Among the largest and most important of these are the far-reaching benefits from watershed protection. Of great importance also is the fact that range use can hardly be eliminated from western agriculture without wrecking the entire structure. Furthermore, range livestock production alone furnishes a livelihood for a large number of people. Other benefits in which both the Federal and State governments share are the sustained taxable value of related lands, income and other taxes, and direct and indirect returns from hunting, fishing, and recreational use.

Essentially the same considerations hold on State range lands as on Federal.

Despite radical readjustments and increased capital investments, the program proposed should work out to the financial advantage of the private owner. He should gradually be relieved of submarginal and high public-value lands. His financial handicaps should be reduced. He should have the advantage of an increasing volume of cheap range feed, of increased unit livestock production, of decreased production costs, and of greater profits.

The Key to Remedial Action

In the complex range pattern, with its multiplicity of interrelated overlapping problems, which require a corresponding multiplicity of interrelated overlapping remedial measures, a clear-cut focal point—a center of responsibility—among public agencies is necessary in planning, initiating, correlating, and consummating action if public obligations are to be redeemed.

This is true of privately owned range lands and livestock, in which the maximum of self-help ordinarily depends on some measure of public leadership and aid to create conditions under which self-help can be effective or even start.

It is equally true of publicly owned range lands where, as already shown, the splitting of jurisdiction of this agricultural problem between different agencies almost inevitably means working at cross purposes, inefficiency, and excessive costs. Furthermore, public lands cannot be divorced from their surroundings. Such lands have a direct and vital bearing on the ranch owner and his welfare and must be handled in full recognition of this fact. This bearing extends far beyond private range lands and livestock to private cropland, and to the entire agricultural structure.

A check of the broader groups of problems and their solution will still further illustrate and emphasize this point of view.

Take for example the broad group of problems centering in the reversal of the range and soil-depletion process, and requiring such action as the removal of large numbers of excess stock.

Or take the equally broad group of ownership and use problems requiring large shifts from private to public ownership, or range restoration on mistakenly cropped lands, or the building of units of economic size.

Or the large number of additional problems of private ownership requiring the removal of financial handicaps or the recognition of the responsibility of stewardship.

Or the problems already referred to involving lands now in public ownership or those hereafter acquired.

Or the problem of knowledge and its application, requiring range and livestock and land-use research and extension.

Or those centering in human wastage in agricultural communities requiring action to insure social and economic security.

The lack of clear-cut centralized responsibility up to the present time has undoubtedly contributed in a major way to the neglect and abuse of the range resource. In far too many instances what has been everyone's responsibility has been no one's responsibility. It seems futile to continue an arrangement which has led to such results. Centralized responsibility affords the only way in which the general public can hope to hold its agencies to a strict accountability.

Any consideration of Federal activities other than the jurisdiction over Federal range lands—research, extension, general agricultural integration, and aid in various other forms—make still more conclusive the fundamental soundness of the centralization of full Federal responsibility in the Department of Agriculture for an activity which is agriculture to the core.

Within their spheres of action the States must face and meet similar problems of responsibility and organization.

IS REMEDIAL ACTION WORTH WHILE?

The program outlined for the solution of the range problem runs into very large sums of money which will constitute a heavy drain, particularly on Federal and State treasuries. Large as they are, these expenditures are only a part of the price which must be paid for the wasteful use and destruction of a great natural resource. Still another part of the price is the time over which the reconstruction effort must continue. It has taken little more than half a century to reduce the productivity of the range by about half, and it will probably take at least as long to bring it back to a grazing capacity equivalent to present stocking. The cost will be a heavy public burden, regardless of the possibility of direct returns that in the long run may make the enterprise self-liquidating.

Is restoration worth while? This question should be raised and squarely faced before a final decision is made. Perhaps the soundest decision can be reached by contrasting what will happen if the effort is not made, with the benefits if it is.

If No Action Is Taken

If drastic and immediate action to restore the range resource is not taken, it seems inevitable that depletion will continue. Whether it continues more or less rapidly than in the past, the end result is bound to be the same—the Great American Desert, once only a name, will become that in fact. If anyone questions the inexorable working of the cause and effect he need only examine the history of the semiarid pastoral countries of southwestern Asia and the Mediterranean. The more precarious range types of the Southwest and Intermountain region will merely be the first to qualify, but the other and more favorable types are certain to follow sooner or later.

The gradual destruction of the basic forage and soil resource will inevitably in time reach the point where the range livestock industry can no longer exist. The range alone can furnish the cheap feed

which is the most important competitive advantage in livestock production of all except one of the 11 far-western States. With the elimination of the range must consequently go the gradual elimination of the western livestock industry itself.

Along with the industry must go its contribution to the meat, wool, and hide, and other requirements of the country. The extent to which this might make the United States dependent on foreign supplies is uncertain, but there can be no question that it will place us in a less favorable position in which to meet future emergency requirements, such, for example, as that of the World War.

No distinction can be drawn between the dependence on the range of livestock and of wildlife. The flood and erosion situation on depleted ranges is rapidly becoming more and more serious, and this tendency would certainly continue and its effect would become more and more far reaching. Not least in importance will be reduction in the effective life of the irrigation reservoirs which depend upon watershed protection.

Crop agriculture is now so closely integrated with the use of the range that it is almost certain to suffer in other ways than impaired water supplies as range problems become more and more acute.

And whatever injures either or both will extend into communities, towns, and cities dependent upon a prosperous agriculture, and affect supply services, banking, transportation, and in fact all other industries which are a part of the existing western civilization. Reduced tax returns will curtail essential public activities.

The social wastage growing out of range depletion and the various maladjustments in the use of range lands has already been very large, but is inconsequential in comparison with the wastage which will be inevitable if any large part of the range is entirely destroyed.

The Benefits from Restoration

An area of 728 million acres of restored and fully productive range cannot be otherwise than a source of perpetual wealth.

The maintenance of this range area would, according to the best information now available, carry at least 17.1 million animal units of domestic livestock 50 years hence, as compared to the 17.3 million units which are now rapidly depreciating the range, and the 10.8 million units which it can now carry in safety (fig. 22). The gain in the value of livestock production between the present and potential grazing capacity would undoubtedly justify the entire annual cost of restoration several times over.

Serious depletion was one of the primary causes of the 1934 Federal expenditure of $100,000,000 to purchase starving western-range livestock. The elimination or the drastic reduction of such expenditures, which range restoration should make possible, would make a major contribution to the cost of the program recommended. From the standpoint of broad public policy the choice lies between mere alleviation by periodic repetition, leaving the basic problem untouched, and striking directly and constructively at a primary cause in order to make such expenditures unnecessary in the future.

Erosion and destructive floods would gradually be reduced to a minimum, and the life of irrigation and other reservoirs greatly extended. The reduction in the annual flood-damage bill alone would

go a long way toward carrying the annual cost of a constructive program. Wildlife could again assume a proper place among the products of the range and make its contributions to western life.

Only by restoration is it possible to make the range contribute as it should to working out a satisfactory balanced and hence a permanently prosperous western agriculture. Sources of livelihood now so badly needed with the passing of the frontier and the replace-

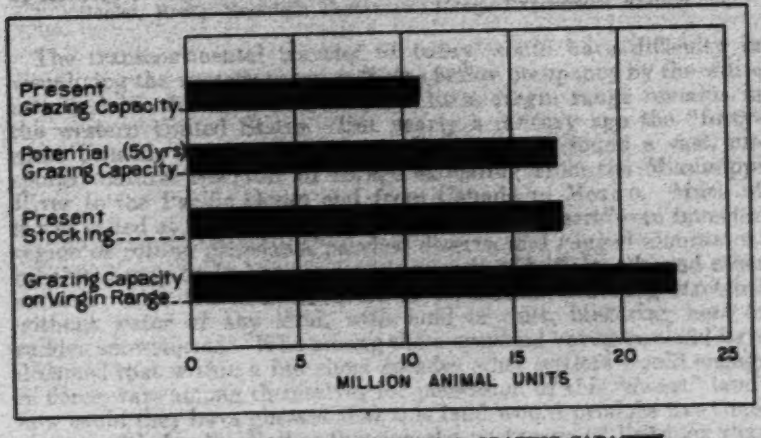
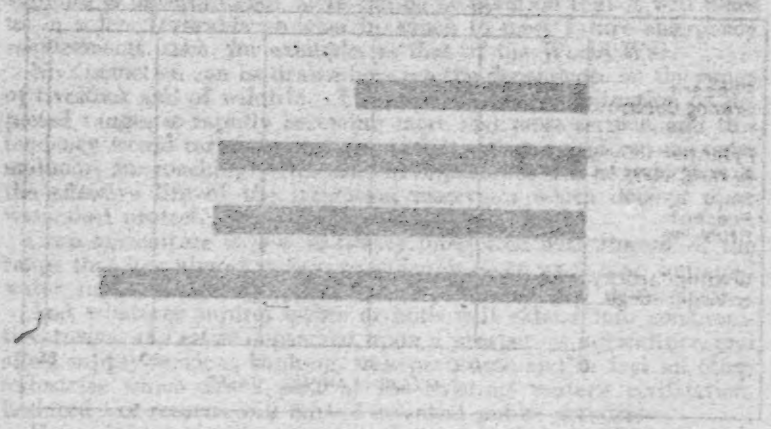


FIGURE 22.—PRESENT AND POTENTIAL GRAZING CAPACITY.

The present grazing capacity of the available range area, estimated at 10.8 million animal units could, it is conservatively estimated, be increased to 17.1 million units in 50 years if the entire range area is placed under management in the immediate future. But even this increase would fall 0.2 of a million units short of what stockmen are now trying to carry on ranges whose productive capacity has already been reduced by more than half. How much longer would be required to reach the original capacity of 22.5 million units no man can say, but it might well be another half century. Aside from human inertia, the chief retarding factor in both instances would be the long, slow process of rebuilding the soil.

ment of labor by machinery in manufacturing, high standards of living, stable communities and general social and economic well-being, reasonable prices to the ultimate consumer, all depend vitally upon the proper handling of natural resources, among which the western range must occupy a conspicuous place.

With such contrasts in probable losses and possible benefits a recommendation for affirmative action is the only one that can be made.



II. THE VIRGIN RANGE

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The transcontinental traveler of today would have difficulty in visualizing the western range as it was before occupancy by the white man and his domestic livestock, for little virgin range remains in the western United States. But nearly a century ago the "forty-niner", on his way overland to the Pacific coast, found a vast, unspoiled natural reservoir of forage extending from the Mississippi River to the Pacific Ocean and from Canada to Mexico. Much of it was called at that time the "Great American Desert"—an immense region of rolling grassland, parched deserts, and rugged mountains; inhabited only by Indians and roving herds of buffalo, elk, and other animals; with treacherous rivers to be forded and long stretches without water of any kind, with mud or dust, blistering heat or sudden snowstorms. Who among these overland voyagers could have dreamed that within a few short decades other settlers would engage in fierce wars among themselves for possession of this "desert" land; how could they have guessed that this land would produce five times more wealth for the Nation through the pasturage of livestock than all the gold they would dig out of the earth with their picks and shovels! For this vast desert, plain, and mountain country was soon to become the great western range.

Before agricultural settlement by the white man, the virgin range comprised the western two-thirds of the United States. If nongrazable lands such as mountain tops, almost barren deserts and dense forests, are excluded, it encompassed nearly 850 million acres. As might be expected for so large an area, there were tremendous variations in topography, soil, and climate. These great differences in environment resulted in correspondingly great differences in the kind of vegetation. In some places the range was a natural grassland that stretched for mile upon mile without bush or tree to break the monotony of the landscape. Other areas, less extensive, were brushy, the intermingled grasses and weeds being inconspicuous though present in considerable quantities. Elsewhere the range was clothed with forests, but frequently these forests were sufficiently open to permit the establishment of shrubs, grass, and herbaceous plants beneath the forest canopy.

Each of these three main classes of vegetation—grasslands, brush, and forests—included several distinctive types, areas characteristically possessing one or more outstanding vegetational features which caught the eye and lingered in the memory of the early-day transcontinental travelers. Their diaries describe how in journeying westward they spent weeks crossing first the tall-grass prairies and then the short-grass plains, "endless" grasslands extending to the very foot of the Rocky Mountains (fig. 25, p. 85). Those who traveled

the Oregon Trail encountered bunchgrass plains in what is now eastern Oregon and Washington, and those who reached the central valley of California saw a similar type. Pioneers who traveled far to the Southwest found near the Mexican border another type, the semidesert grass.

The overland travelers eventually were obliged to leave the open, grassy plains for the more laborious passage through the brush of deserts, foothills, and lower mountain slopes. Along the northern trails this type was sagebrush in which there was considerable grass; in the far Southwest was a quite different type consisting of various southern desert shrubs, such as the creosotebush and saltbushes (fig. 30, p. 95). In southwestern Wyoming, Utah, Nevada, and the Southwest the pioneers encountered salt-desert shrubs on alkaline soils, and in California these adventurers of covered-wagon days found chaparral, a dense mixture of a hundred different brush and tree species forming almost impenetrable thickets on the foothills.

On the mountain sides above the brush fields were open forests of gnarled pifion and juniper (fig. 34, p. 101). jAt still higher elevations, or where the soil was more moist, they encountered parklike open forests of ponderosa pine and of aspen and fir. Denser forests of spruce and fir, western white pine, redwood, Douglas fir, spruce, hemlock, and lodgepole pine occurred over large areas but intermingled with these forests were open, grassy meadows of varying size.

A DETAILED PICTURE OF VIRGIN RANGE TYPES

This varied succession of range types was found widely scattered throughout the West, often extending without a break over large areas. Other types were local only. The descriptions of the individual types which follow give a more detailed picture of the many different kinds of grazing lands found in the virgin range. The approximate total acreage [3] and grazing capacity of each range type in its virgin condition are given in the next chapter.

Tall Grass

Probably no part of the western range produced palatable and nutritious forage in such abundance as the tall-grass prairies. Not only was there an enormous volume of vegetation on the 42 million acres in this type,[4] but there was scarcely a grass, weed, or shrub present which could not be eaten by grazing animals. When the white man first settled in the Midwest, the prairie extended wedgelike from Illinois northwesterly into Canada and southwesterly into Texas. Its western boundary, though very irregular, was in the Dakotas, Nebraska, Kansas, and Oklahoma, where the tall grass of the prairies gradually merged with the short grass of the plains.

The vegetation of the prairies varied with topography, soil, and moisture, but always dominating these gently rolling lands was a mixture of several species of tall grass. An intermingling of half-

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[3] Areas of range types in their virgin condition are approximations based on estimates by skilled observers and tempered by reasonably accurate information on extent of the types 50 to 100 years ago, their recent expansions and contractions and the area in each type which has been used for agricultural crops, roads, etc.

[4] This was the area of tall grass within the limits of the present range, west of the boundary shown in fig. 25, p. 88. East of this boundary, the prairie tall-grass type covered approximately 210 million acres, or a total of about 252 million acres.

shrubs and multitudinous flowers gave the landscape variety and color. In the moist bottom lands sloughgrass grew tall as a horse's back. On the drier slopes other grasses, 2 or 3 feet tall, such as the bluejoint turkeyfoot ("big bluestem"), the prairie beardgrass ("little bluestem"), Indian grass, wild-rye, and switchgrass formed societies, characteristic in themselves, but all a part of the greater formation that was the prairie. The still drier uplands were carpeted with shorter grasses, bluestem, needlegrasses, side-oats grama, and in some places by the bunch-forming sand dropseed. Interspersed with these were semiwoody and herbaceous plants that bloomed with the change of season: goldenrods, wild daisies, the wreath aster, and a host of associates. The silvery canescence of the leadplant or "prairie shoestring", the bright yellow of the sunflower, the white of the anemone, and the brilliant orange of the butterflyweed, or "pleurisy-root", intermingled with the green background of the prairie grasses in a beautiful and intricate mosaic. In late summer these bright colors slowly faded as the vegetation dried and the prairie became a vast sea of rusty brown.

The prairie was productive. It is hard to picture today the vast numbers of wild fowl—golden plovers, prairie chickens, geese, and ducks—that inhabited this region. Countless bison grazed in massive herds over the country where later the settler was to find good pasturage for his livestock. Its vastness, its productivity, and the ease with which it restored itself all contributed toward making the prairie an exceedingly valuable range resource.

Short Grass

As the pioneer moved westward the tall-grass prairies gradually gave way to an endless carpet of sod-forming grasses much shorter than those of the prairies. These vast short-grass plains were for the most part fairly level and extended from the Panhandle of Texas northward beyond the Canadian border. The eastern edge was near the center of the present States of Kansas, Nebraska, and the Dakotas; westward it stretched to the very foothills of the Rocky Mountains, forming a belt from 300 to 600 miles wide and 280 million acres in extent.

The plains country received very much less rain than the prairies, and, as a consequence, was dominated by grama and buffalo grass, which needed relatively little water. The deeper-rooted, moisture-requiring tall grasses and herbs so typical of the prairies were almost entirely excluded.

This vast area of sod-grasses was not, however, uniform in composition throughout its entire extent. Along the western edge of the short-grass belt in Montana and Wyoming, the short-grass type alternated with the sagebrush and was further modified by a generous admixture of several other valuable forage plants including wheatgrass and junegrass. Further south, along the western edge of the short-grass plains, the grama was mixed with a great variety of palatable herbaceous plants, some of which also were found in the nearby mountains. In what is now western Kansas and Oklahoma, eastern Colorado, northeastern New Mexico, and the Texas Panhandle, buffalo grass, galleta grass, and other grasses appeared in greater abundance than in the more northerly portions of the type

Various annuals of moderate or low palatibility also appeared: Woolly Indian-wheat, sixweeks fescue, rough pennyroyal, and western stickseed; and during wet years, perennial grasses such as needle-and-thread and sand dropseed, together with various weeds, developed a taller cover. Elsewhere, bluestem ("western wheatgrass") and western needlegrass added greatly to the luxuriant appearance of the short-grass cover. In the transition zone between the prairies and the plains, the sod cover was more open, and included deep-rooted plants of the tall-grass type such as "wire-grass" and bush morning-glory.

Grama, buffalo grass, and most of the other species of the short-grass type were palatable and nutritious. Although the short grasses matured early, their cured leaves remained as valuable forage and were available the year round except when covered with snow. Injurious species were at a minimum. The high grazing capacity of the range is indicated by the enormous herds of buffalo which roamed these plains.

Pacific Bunchgrass

In western Montana, southwestern Idaho, eastern Washington and Oregon, and in central California the pioneer found a luxuriant grassland that resembled the prairies but with the additional characteristic of many grasses growing in tufts or bunches. This bunchgrass type was so luxuriant in its virgin condition that explorers made frequent comments concerning it. Commander Wilkes (*186*)[1] wrote in 1841 of north central Oregon: "These hills, as well as the country nearer at hand, were covered with a natural hay or bunchgrass, which affords very nutritious food for cattle", and again near Walla Walla in eastern Washington, "To the north and south are extensive prairies, covered with the natural hay of the country, on which the cattle feed." Frémont (*55*) wrote of eastern Oregon in 1843: "The mountains were covered with good bunchgrass"; and later Stuart (*198*) recorded:

> We crossed the Rocky Mountain Divide on the 10th day of October, 1857, where the station called Monida now is on the Oregon Short Line railroad. As soon as we had crossed the divide a wonderful change appeared in the country. Instead of the gray sagebrush covered plains of Snake River, we saw smooth rounded hills and sloping benchland covered with yellow bunchgrass that waved in the wind like a field of grain.

These testimonials as to the character, productivity, and palatability of the vegetation abounding in this territory are further substantiated by scattered remnants of the original vegetation, not so easily read as diaries but far more realistic. Cemeteries, fence corners, and moderately grazed fields indicate an abundance of palatable and nutritious bluebunch wheatgrass, Idaho fescue, giant wild-rye, bluegrass, and needlegrass. Not so abundant, but highly important as forage, were palatable weeds, such as balsamroot, hawksbeard, mountain-dandelion, and sunflower.

Farther south, in California, was a similar native bunchgrass prairie closely resembling the bunchgrass prairies of the Pacific Northwest. The more important forage species were bluegrass, june-

[1] Italic numbers in parenthesis refer to literature cited, p. 557.

grass, oniongrass, needlegrass, wild-rye, and squirreltail grasses. Clements (*54*) describes a nearly continuous area of California needlegrass several hundred miles long which once existed there. Mixed with these more valuable grasses were clovers, lupines, sunflowers, poppies, and innumerable other herbs in infinite variety.

Although totaling only about 61 million acres and small in comparison with the tremendous area occupied by the short-grass plains, the Pacific bunchgrass type was undoubtedly the finest grassland west of the Rocky Mountains. It provided valuable forage for immense numbers of wild animals and later was to become equally valuable for pasturage of domestic livestock.

Semidesert Grass

South of the short-grass plains and paralleling the Mexican border in Texas, New Mexico, and southern Arizona occurred a discontinuous belt of arid grassland which resembled the plains to some extent. But the vegetation of these semidesert grasslands was quite different from that of the true short-grass type. In addition to the grasses, many parts of the area supported a scraggly growth of thorny shrubs and low trees. It covered approximately 93 million acres, extending over broad, flat valleys, low hills, and mesa tops and up onto the lower slopes of the mountains.

The most valuable forage plants in this type were three grasses: Rothrock ("crowfoot") grama, black grama, and curly-mesquite. In some localities Rothrock grama formed rather dense stands having the appearance of fields of short cereal, and on the lower foothills curly-mesquite occurred in sufficient density to form a sod that in many ways resembled the buffalo-grama sod of the plains. These nutritious grasses, however, though distributed widely throughout the type, comprised only a relatively small portion of its total area. More widely distributed was the black grama, which sparsely covered the sandy and gravelly slopes between the river bottoms and the foothills.

Scattered through this grass type were thorny shrubs and dwarfed trees such as mesquite, mimosa, catclaw, and other acacias, hackberries, creosotebush, jojoba, ceanothus, and low-growing live oaks. Interspersed with these were pricklypear and other cacti, yucca or Spanish-bayonet, and other plants characteristic of regions of little rainfall. None of these latter species were of appreciable value for forage.

The diaries of the early explorers and the accounts of later travelers through the Southwest seldom or never mentioned any difficulty in finding forage for their animals. The immense numbers of pack and draft animals and cattle that year after year followed the Butterfield and old Texas-California cattle trails through this type were able to maintain themselves on the natural forage during months of travel.

Sagebrush-Grass

One of the most distinctive range types which the early travelers encountered was the sagebrush-grass. The pioneers of the Oregon Trail seldom were out of the sagebrush type from the time they entered it in eastern Wyoming until they reached the Cascade Range in central Oregon; or if they turned southward in southern Idaho

they found it all the way through Nevada to the foothills of the Sierras.

The traveler, accustomed to the green prairies of the Midwest, found the dull, gray expanse of the sagebrush forbidding and barren, but in reality this type had many attractive features.

There are many lovely plants that blossom in early spring, filling the air with fragrance, and in summer and fall the yellow of sunflowers and of the still more plentiful rabbitbrush, a relative of the goldenrod, frequently give broad dashes of brilliant color. Beneath the sagebrush in a state of nature nutritious bunchgrass grows abundantly (*112*).

A significant feature of the virgin sagebrush type was the abundance of palatable grasses and weeds which grew under and between the shrubs. Prominent among these were the wheatgrasses, bluebunch fescue, needlegrasses, wild-rye, Indian ricegrass, wild geranium, balsamroot, and yarrow. Of lesser importance as forage but of frequent occurrence were hawksbeard, phlox, sunflower, lupine, and many other species. This cover of grass and weeds beneath the sagebrush varied in density with soil and moisture conditions from a thin stand such as in the Snake River plains of Idaho to a fairly thick sod as in the mountains along the foothills in Montana.

Occasional very dense stands of sagebrush were found, but as a rule the individual plants were several feet apart, forming open diminutive forests from 2 to 7 feet in height. Mingled with the silvery gray foliage of the sagebrush were other browse species such as bud sagebrush ("bud-sage"), bitterbrush, and rabbitbrush.

Throughout its range the sagebrush type occurred in streaks and patches along rivers and streams as well as on areas of poorer and drier soils. It was found on extensive plains, on the rolling foothills, and extended upward on dry mountain slopes to merge with open forests of piñon-juniper and ponderosa pine.

In its primitive condition, the rich understory of grasses and weeds beneath the "sage" provided abundant feed in spring and fall for deer and other animals that migrated between plains and foothills and the higher elevations. On the broad plains, nutritious forage was available throughout the year. Because of its widespread occurrence over 90 million acres and its high forage value, the sagebrush-grass type was unquestionably one of the most important of all the original western ranges.

Southern Desert Shrub

Driest of all the range types was the southern desert shrub, of which the greater portion was in southwestern Arizona, southern Nevada, and southeastern California. Smaller areas occurred in southern and western Texas and southern New Mexico near the Mexican border. The Mohave Desert is included within this type as are also the lower valleys of the Rio Grande and of the Colorado, Gila, and Pecos Rivers. In its original condition only 25 of the approximately 51 million acres in this type were of appreciable value for grazing.

Owing to extremely high temperatures and very low rainfall, this type has never produced sufficient vegetation to make it a very dependable part of the range resource. Travelers, however, invariably were impressed with the bizarre and varied appearance of the plants on these sun-scorched desert lands. There was little uni-

formity in the plant cover. Gray stretches of desert saltbush formed dense thickets 3 or 4 feet tall in the valleys. Over extensive tracts, widely spaced creosotebushes gave the appearance of scrubby orchards. On the surrounding hills and ridges were varied forms of cacti, centuryplants, agaves, and yuccas; this portion of the desert must have been interesting, picturesque, and even weird with its great columnar cacti, spiny paloverdes, the radiating stems of ocotillo, and the beauty and variety of myriads of bright-colored flowers which appeared for brief intervals after the infrequent rains.

Over most of the range, palatable forage was provided by mesquite browse and weeds which sprang up after rains. With increase in elevation toward the fringing mountains, however, the vegetation became more abundant, and at the highest elevations within the type were such true forage plants as Rothrock and black gramas, alkali sacaton, lovegrasses, and three-awns, and in certain situations saltgrass and galleta.

Salt-Desert Shrub

On the rolling alkaline soils of southwestern Wyoming, southern Idaho, Utah, and Nevada was the salt-desert shrub type, covering about 42 million acres, which resembled a low, scattered sagebrush formation. The predominant vegetation was a mixture of palatable low shrubs and scattered grasses. The most nutritious browse plants were shadscale, bud sagebrush, winterfat, and rabbitbrush. The most valuable grasses were wild-rye, squirreltail, Indian ricegrass, galleta, and alkali sacaton, and although these seldom were thick enough to develop a sod they formed fairly close stands in the less alkaline situations.

The composition of the plant cover varied according to the salt content of the soil, and consequently different areas were dominated by different species. Where the salt content was extremely high, pickleweeds and seepweeds occurred over great level expanses, but these were unpalatable and never of value for grazing. Under more favorable soil conditions the alkali sacaton formed a close sod over extensive flats where clumps of yellow-flowered rabbitbrush, 2 or 3 feet high, frequently appeared. On moderately alkaline areas, greasewood plants 2 to 5 feet in height were more or less evenly spaced from 5 to 8 feet apart; their bright green foliage contrasted strongly with the ashen hue of the low, hemispheric clumps of shadscale which frequently grew in mixture with the greasewood.

Even in its primitive condition the percentage of ground covered by the salt-desert vegetation was slight. A recent survey in Nevada of railroad rights-of-way which have been fenced for more than 30 years showed that grass covered only 1 percent and browse less than 3 percent of the total ground area. But even this apparently scant cover of vegetation furnished feed for thousands of game animals each winter.

Piñon-Juniper

The first forest type usually encountered by the pioneers after crossing the Great Plains on their westward trek was the piñon-juniper. These low-growing, open forests of piñon pines and junipers occurred over 74 million acres from the eastern foothills of the Rocky Mountains in Colorado westward to central Oregon and

south through the foothill country of Utah, Nevada, eastern California, Arizona, and New Mexico. On the lower slopes of high mountains the piñon-juniper type formed a transition zone between the treeless sagebrush or similar shrub types and the denser forests growing at higher elevations. In many places, particularly on the elongated low ridges of Nevada, piñons and junipers were the only forest trees present in any abundance. Here the type occurred as large islands in a sea of sagebrush. The piñon-juniper type extended without a break over thousands of acres throughout the Southwest, and long fingers of this fringe forest type followed low, rocky ridges and other broken ground out into the semidesert plains.

The piñons and junipers were short, dense-crowned trees 20 to 40 feet tall, the individual trees generally growing rather far apart. Along the upper edge of the piñon-juniper belt, the pines often dominated the forest mixture, whereas, at the lower edge of the belt, the junipers ordinarily occurred in greater abundance than pine.

The piñon-juniper type was an important forage resource. The wide spacing of the trees permitted the development of considerable browse such as mountain-mahogany, bitterbrush, and cliffrose, as well as many palatable grasses and weeds, the more prevalent of which were the gramas, needlegrass, wheatgrass, bluegrass, and fescue.

Woodland-Chaparral

Around the sides of the great central valley of California, on the low hills along the Pacific Coast from San Francisco south to Mexico, and in southern Arizona, the early-day traveler found vast brush fields composed of not one but dozens of different species of shrubs. These almost impenetrable thickets of bushes and stunted hardwood trees later acquired the name "chaparral." Associated with these chaparral thickets were large areas of comparatively open woodland, parklike stretches characterized by various species of oaks, and an understory of palatable grasses and herbs. Just as the piñon-juniper type elsewhere in the Southwest formed a transition zone between the grass or desert-shrub vegetation of the plains and the forests of the higher mountain slopes, so the woodland-chaparral formed a transition zone between the grass types and the higher mountain forests in southern California and Arizona. In California alone, the woodland-chaparral type covered about 10 million acres.

Although more than a hundred different species of shrubs and dwarfed trees intermingled to form this peculiar plant cover, its species composition varied considerably in different parts of the type. The most important species were highland live oak, poison-oak, scrub oak, hollyleaf cherry, sumac, ceanothus, and manzanita. At varying elevations the shrub species gradually merged with open oak woodlands.

The woodland portions of the type supported a good growth of valuable forage grasses and weeds. There was no available grass or herbaceous forage beneath the dense canopy of the brush portions of this type, and the brush itself was of low palatability. The chaparral, however, had enormous value for watershed protection, since its dense cover prevented soil washing and thus played a prominent part in preserving lower, more valuable grasslands.

Open Forests

Valuable forage occurred in the 131 million acres of open forests that grew on the slopes of practically every mountain range from the eastern foothills of the Rockies to the slopes of the Cascades and the Sierras. In these forests the trees were fairly wide-spaced, and a grassy floor beneath the trees added to a parklike appearance. Numerous clear mountain streams and the easy accessibility of the grass cover contributed to making these areas an extremely valuable part of the forage resource.

The most extensive areas of grazing land in the open-forest type were found under the ponderosa pine forests which occurred in large bodies throughout the West. In many localities the prevailing open-forest type was a pure stand of ponderosa pine; elsewhere it was a mixed stand of ponderosa pine, sugar pine, and incense cedar or a mixture of ponderosa pine and Douglas fir. At high elevations in the Rocky Mountains there were parks and meadows in openings between stands of Engelmann spruce and alpine fir. Here and there were areas of low-growing oaks, maples, and other mountain brush. In Colorado and adjacent Southwestern States the type included tracts of aspen and Douglas fir. Throughout the type were mountain meadows of luxuriant grass and palatable weeds.

Almost everywhere in the open forests was abundant forage composed of many different species of shrubs, grasses, and weeds. As might be expected, the forage species varied considerably throughout this very large region, depending on climate, soil, and to some extent on the kind of overtopping forest cover. For the type as a whole, however, the many valuable forage plants included blue grama, bluestem, various fescues, "beardless bunchgrass", wheatgrass, pinegrass, junegrass, bluegrasses, redtop, alpine timothy, needlegrasses, ricegrasses, and elk sedge; wild geranium, bluebells, yarrow, succulent vetches, and other nourishing weeds and palatable browse such as snowberry, bitterbrush, and mountain-mahogany.

These open forests and mountain meadows had a high value for forage. As a rule, this type occurred at rather high elevations, and its forage matured later than that of the lower ranges. For this reason the open-forest ranges later were to become an extremely important link in the grazing cycle for domestic livestock providing the all-important summer pastures and, in combination with the lower ranges, making possible yearlong grazing.

Dense Forests

Not all of the forests of the West were suitable for grazing. Certain forest types were so dense that little herbaceous or shrubby vegetation was able to live in the deep shade, or if herbage did develop it was of low forage value. Included in the dense forest types were the western white pine–western larch forests of northern Idaho, thickets of lodgepole pine throughout the Rocky Mountains, redwood stands along the northern California coast, the fog-drenched Sitka spruce–western hemlock and Douglas fir forests of western Oregon and Washington, and parts of the Engelmann spruce–alpine fir forests of the high Cascade Range and the Rocky Mountains. Here and there in these dense forests were open, grassy meadows.

In the aggregate, these dense forests covered a very large area and comprised about 68 million acres. Occasional fires, started by lightning or by Indians, removed the forest cover temporarily, and for a few years deer and other wild animals found considerable feed in the burned areas, on which generally developed a good cover of such palatable plants as peavine and fireweed, until new forest growth shaded out these succulent plants.

WHAT THE RANGE RESOURCE OFFERED A GROWING NATION

In the days of the "Forty-niners" there were few settlements in all that vast territory lying between the Mississippi River and the Pacific Coast. True, the Spaniards had a few herds of cattle and sheep in the Southwest as early as 1598, and the Mormons in 1847 established a small colony on the shores of a great salt lake near the western foothills of the Rocky Mountains; there were a few military posts scattered here and there, and at various strategic points were isolated trading establishments of the great fur companies; and, of course, a few small, struggling communities had taken root in the fertile valleys adjacent to the Pacific Ocean.

Except for these rudimentary beginnings of settlement, the whole of the far-flung expanse of prairie, plain, desert, and mountain highland was virgin territory. It was virgin country in 1540 when the Spanish captain, Coronado, led the Conquistadores up from Mexico through what is now Texas and on northward over the lush grass of the never-ending plains. It was the free and unchallenged home of the buffalo and antelope in 1805 when Lewis and Clark made their intrepid march to the mouth of the Columbia. And it was still virgin territory in 1835 when Colonel Dodge and his party of Government explorers spent the entire summer following the Platte River toward its source, traveling across the Great Plains, along the frontal wall of the Rockies, and returning eastward by way of the Arkansas River. As late as 1858, buffalo roamed over the land where Denver now stands. Those who set forth three-quarters of a century ago to cross this vast, uncharted, little-known wilderness saw the land as Coronado saw it three centuries before. They saw a virgin range, an enormous, untapped natural resource.

This virgin range exhibited a wide variation in plant cover, but everywhere except in the desert areas, there was an abundance of palatable and nutritious plants suitable for the pasturage of wild game and, later, for domestic livestock. Before white settlement the range was used only by wild game. Although these animals were present in very large numbers, occasionally overgrazing local areas and variations in forage production were caused by droughts, some of which undoubtedly were as severe as those experienced in recent years, the range by and large was able to maintain itself. It would have continued to do so if the white man had not upset its natural and fairly stable equilibrium.

The magnificent opportunities for prudent utilization of this great natural resource could not have been fully appreciated by those who settled the range; for the story of the range is in part one of high hope and lofty ideals, and in part one of indifference to the welfare of the generations to follow. It is a story of the prodigal exploitation of a vast natural resource on an enormous scale.

III. THE WHITE MAN'S TOLL

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If the "Forty-niner" could but repeat his westward journey today, how different the range would appear! Where less than a century ago he spent weary weeks guiding his ox team over rolling prairies, wind-swept plains, and rugged mountains; where were but wagon

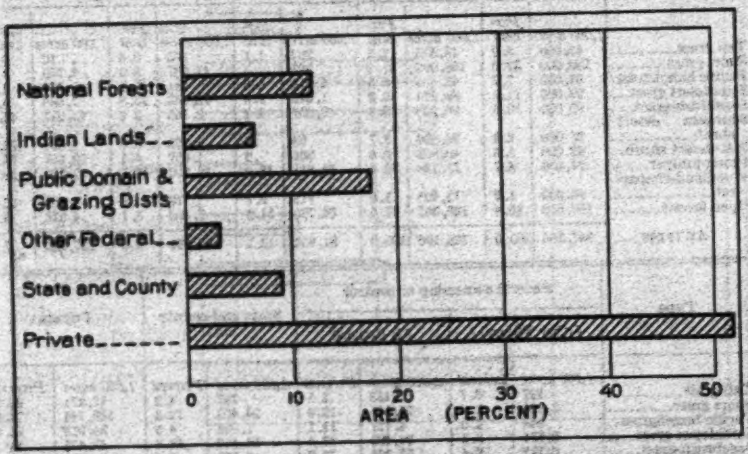


FIGURE 23.—OWNERSHIP DISTRIBUTION OF THE PRESENT RANGE AREA.

Of the immense area of "free range", more than half has passed into private ownership. National forests, Indian lands, and public domain divide up about 36 percent in the ratio, roughly, of 2-1-3.

tracks and isolated Indian villages in the days of the gold rush, he now would find a network of roads, farmsteads, cities, and towns. Enormous areas throughout this western country would still have somewhat the appearance of the "endless grasslands" that he knew; but beneath the appearance is a change that might elude the "Forty-niner"—the great depletion in quality and quantity of the forage resources that has taken place in the last 50 or 60 years.

Widespread, continuous, and exhaustive use of the forage has changed the whole character of the virgin range. The outstanding changes have been (1) the passage of much of the land from Federal ownership to other forms of control, (2) a reduction in the area available for range use, (3) a tremendous decrease in the quantity and quality of the forage, and (4) deterioration of the basic resource, the soil itself.

The ownership pattern of the virgin range has changed from virtually complete Federal ownership to a bewildering mosaic of intermingled State, county, municipal, private, Federal, and other ownerships. Even the land in Federal ownership or control is under various jurisdictions, such as the national parks and monuments, national forests, Indian lands, grazing districts, and unreserved public domain. Table 5 indicates for the present range area of 728,000,000 acres the approximate acreage in each of the several classes of ownership. The proportional area in each ownership is illustrated in figure 23.

TABLE 5.—*Distribution of virgin and present range areas by ownership or control and plant types*

Type	Approximate area of virgin range [1]		Present area, all ownerships		Federal ownership or control					
					National forests		Indian lands		Public domain [2]	
	1,000 acres	*Per cent*	*1,000 acres*	*Per cent*	*1,000 acres*	*Per cent*	*1,000 acres*	*Per cent*	*1,000 acres*	*Per cent*
Tall grass	42,000	5.0	13,813	2.5	262	1.1	106	0.6	10	0.1
Short grass	260,000	32.0	198,062	27.2	983	.5	11,627	5.9	9,759	4.9
Pacific bunchgrass	61,000	7.2	42,554	5.8	1,714	4.0	461	1.1	1,689	4.0
Semidesert grass	98,000	11.6	66,274	12.3	1,636	1.8	12,833	13.9	7,666	5.6
Sagebrush-grass	96,000	10.6	96,228	13.5	3,627	3.6	2,185	2.2	43,237	44.8
Southern desert shrub	25,000	2.9	26,806	3.7	96	.4	3,409	3.9	6,434	23.9
Salt-desert shrub	42,000	5.0	46,858	6.6	266	.9	1,657	4.1	30,657	75.0
Pinon-juniper	74,000	8.7	75,726	10.4	13,611	18.2	10,353	13.7	22,303	29.5
Woodland-chaparral	10,000	1.2	13,466	1.8	712	5.3	78	.6	1,693	12.6
Open forests	136,500	15.4	126,367	17.4	64,785	51.3	7,190	5.7	4,235	3.4
All types	847,500	100.0	728,196	100.0	87,064	12.1	49,301	6.8	127,702	17.5

Type	Federal ownership or control				State and county		Private	
	Other Federal [3]		All Federal					
	1,000 acres	*Percent*	*1,000 acres*	*Percent*	*1,000 acres*	*Percent*	*1,000 acres*	*Percent*
Tall grass	137	0.7	488	2.5	787	4.2	17,271	93.3
Short grass	3,166	1.6	25,545	12.9	24,403	12.3	148,144	74.8
Pacific bunchgrass	983	2.0	4,727	11.1	1,964	4.5	35,913	84.4
Semidesert grass	2,734	3.1	24,409	27.3	16,440	18.4	48,435	54.3
Sagebrush-grass	6,147	6.4	55,179	57.3	6,556	6.8	34,791	36.0
Southern desert shrub	1,520	5.7	10,461	38.9	5,792	21.5	10,643	39.6
Salt-desert shrub	2,000	4.9	34,690	84.9	927	2.3	5,251	12.8
Pinon-juniper	4,661	6.0	31,036	67.4	3,003	6.0	20,909	27.6
Woodland-chaparral	120	.9	2,603	19.4	163	1.2	10,640	79.4
Open forests	1,750	1.4	75,049	61.8	4,750	3.7	43,586	34.5
All types	22,997	3.2	287,134	39.4	65,516	9.0	375,546	51.6

[1] Exclusive of area east of boundary line shown in fig. 1. In addition to area shown here, the tall grass type is estimated to have covered 210,000,000 acres east of the boundary line shown in fig. 1.
[2] Including grazing districts.
[3] Exclusive of 1,217,000 acres of grazable land in national parks and monuments, only 40,000 acres of which are actually grazed.

Changes in area have occurred in nearly every major plant type. Some have become larger. The sagebrush-grass range, for instance, has expanded at the expense of adjacent types from about 90 million to more than 96 million acres, and in California the woodland-chaparral vegetation covers 3.4 million acres more than at the time of white settlement. Some of the range types are considerably smaller, as, for example, the tall-grass prairie, much of which is now devoted to agricultural crops. The Pacific bunchgrass range also

has become considerably smaller, because a large part has been used for wheat production, orchards, and other agricultural crops, and because of the inroads made by encroaching sagebrush. The proportional distribution of the present range area in the different plant types is shown in figure 24.

In every part of the western range, lands have been taken for cities, roads, and for other needs of settlement. All told, as detailed in table 5, the total area of open range land is about 119 million acres less today than a century ago.*

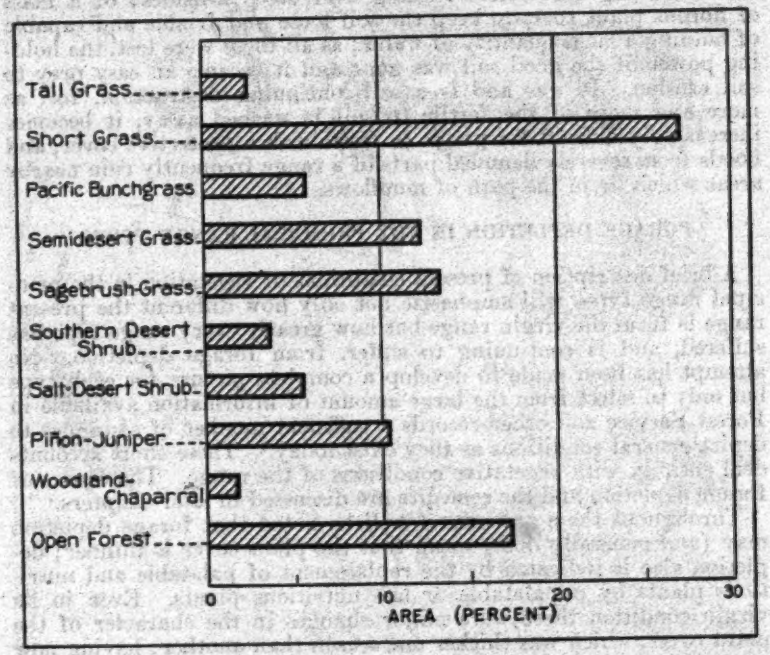


FIGURE 24.—TYPES OF RANGE FORAGE.

One-fourth and more of the present range area is in the very valuable short-grass type. The first four principal grass types (shown in fig. 25) account for nearly a half of the total area.

By far the most significant departure from virgin range conditions is the change in the plant cover. Although varying in density under different forms of management, the plant cover in every range type is depleted to an alarming degree. Many valuable forage species have disappeared entirely. Palatable plants are being replaced by unpalatable ones. Worthless and obnoxious weeds from foreign countries are invading every type. And throughout the entire western range the vegetation has been thinned out until even

* About 2 million acres of former range have been used for cities, highways, and other needs of settlement; about 116 million acres for farm crops; and 1 million acres of grazable lands are included in national parks and monuments. Also not included are about 68 million acres of dense forests and 80 million acres of deserts and inaccessible areas which never have been usable as range.

conservative estimates place the forage value at less than half of what it was a century ago. This loss in forage values from virgin range conditions is referred to as "range depletion."

Accompanying the loss in plant cover has come about an inevitable soil deterioration. Depletion of the plant cover meant the loss of a shielding cover of herbage to break the force of rains and ease the water gently into the soil; of a litter cover of dead and decaying leaves to filter the running water and thus prevent clogging the soil pores with silt; of a generous admixture of humus to aid in catching and absorbing the waters rushing over steep hillsides; of a mass of fibrous plant roots to keep the soil loose and friable and capable of holding a large quantity of water; as all these were lost, the holding power of the good soil was gone and it became an easy prey to soil erosion. It was and is a self-continuing destruction, for, as more and more of the fertile topsoil is washed away, it becomes increasingly difficult for plants to reestablish a protective cover, and floods from severely denuded parts of a range frequently ruin nearby areas which lie in the path of mudflows.

FORAGE DEPLETION IN THE PRINCIPAL RANGE TYPES

A brief description of present conditions of vegetation in the principal range types will emphasize not only how different the present range is from the virgin range but how greatly every range type has suffered, and is continuing to suffer, from forage depletion. No attempt has been made to develop a complete picture for each type but only to select from the large amount of information available in Forest Service and other records a sufficient number of examples to depict general conditions as they exist today.[1] These short accounts deal entirely with vegetative conditions of the range. The causes of forage depletion and the remedies are discussed in later chapters.

Throughout these accounts it will be noted that forage depletion may (and generally does) mean that the plant cover is thinner; depletion also is indicated by the replacement of palatable and nutritious plants by unpalatable or less nutritious plants. Even in its virgin condition there were minor changes in the character of the plant cover, which was thicker one season than another; having now more plants of a certain species, now fewer. But in general there was a biological balance, a natural equilibrium, which year in and

[1] These are for the most part taken from unpublished data of the Forest Service. For many years the Forest Service has collected data on range conditions but to obtain more information on the present range, especially for areas outside the national forests, an extensive survey of the entire western range was started in 1933 and completed in the fall of 1935. The tables presented here are based upon the observations of more than 100 Forest Service officials, skilled in judging range conditions and familiar with the country examined. As a basis for judging range conditions these men had the results obtained through periodic reexaminations over many years of 6,000 permanently marked sample plots. In addition, forage conditions on more than 14,000 sample plots were estimated during the 4 years the survey was in progress.

Knowledge of original forage conditions was obtained by examination of remnants of the virgin range and of "protected" areas such as ungrazed fence corners, cemeteries, and railroad rights-of-way where the present vegetation is at least indicative of virgin range conditions. The forage values of present ranges were estimated in terms of those of the virgin range, and present range lands were grouped into four broad classes: 0–25, 26–50, 51–75, and 76–100 percent decline from original forage values. A map (fig. 32, p. 110) was prepared, outlining in a general way these four broad classes of forage depletion. Comparison of this map with those showing distribution of range types (figs. 28, 30, and 34) and with estimates of land ownership was the basis for preparation of the forage depletion tables presented in this chapter.

The plant types described are generalized, each inevitably including small areas of other types. The principal subtypes are detailed in the appendix, p. 600. A similar generalization is unavoidable in delimiting the depletion classes.

year out maintained the distinctive character of the plant type, only occasionally upset by certain natural phenomena such as drought, fire, and localized overgrazing by big game animals.

When the white man came, his disturbance of this balance was of a more far-reaching nature. He allowed too many of his grazing ani-

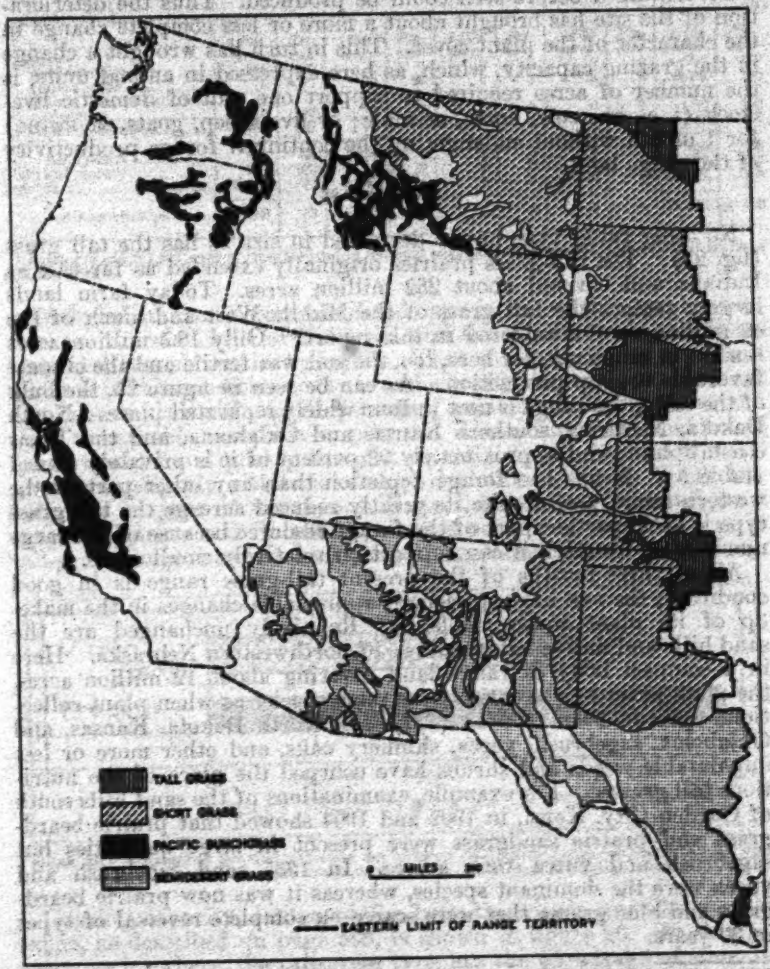


FIGURE 25.—The principal grass types within the boundary of the present range, among which the short-grass type takes first place in area and grazing value.

mals to use the range, with the result that thinning of the plant cover and packing of the soil induced soil erosion and made natural regeneration more difficult for the remaining plants. Early grazing prevented the development of adequate seed crops. These and other factors entirely changed the site conditions and brought about large changes in the character of the vegetation. As a rule, it was the

poorer plants which were able to survive on the deteriorated sites, and eventually they gained possession of the areas. In some instances, these were the plants best able to endure the deteriorated site conditions; in others, the plants that domestic livestock would not eat obviously were left to reseed the area while plants relished by livestock were consumed before seed could be produced. Thus the deterioration of the site has brought about a more or less complete change in the character of the plant cover. This in turn has wrought a change in the grazing capacity, which, as here expressed in animal units, is the number of acres required to support one unit of domestic livestock (i. e., one cow, horse, or mule; or five sheep, goats, or swine) for 1 month without endangering the continued forage productivity of the range land.

Tall Grass

No other range type has so decreased in size as has the tall grass (fig. 25). The tall-grass prairies originally extended as far east as Indiana and covered about 252 million acres. Today farm lands largely replace the tall grass of the Middle West and much of the 42 million acres considered in this report.[8] Only 18.5 million acres remain in range use, for here, too, the soil was fertile and the climate favorable to crop production. As can be seen in figure 25, the bulk of the tall-grass range is now in four widely separated places—North Dakota, Nebraska, southern Kansas and Oklahoma, and the Texas coastal plain; and approximately 93 percent of it is privately owned (table 5). It has less forage depletion than any other part of the western range, and despite its greatly reduced acreage the tall-grass type is an important part of the forage resource because of the large numbers of livestock it can support on relatively small areas.

About three-fourths of the present tall-grass range is in good condition; the rest has experienced appreciable changes in the makeup of its plant cover (table 6). Relatively unchanged are the sand hills and native hay meadows of northwestern Nebraska. Here in a compact body of range land covering about 12 million acres, the plant cover has essentially the same species as when plant collections were made in 1839–58 (*131*). In North Dakota, Kansas, and Oklahoma, sagebrush, yucca, shinnery oaks, and other more or less unpalatable weeds and shrubs have usurped the place of the nutritious tall grasses. For example, examinations of the sand hills south of Garden City, Kans., in 1902 and 1904 showed that prairie beardgrass and prairie sandgrass were present in large quantities but sagebrush and yucca were scarce. In 1935 sand sagebrush and yucca were the dominant species, whereas it was now prairie beardgrass and blue grama that were scarce—a complete reversal of types in 30 years.

[8] As already stated in the previous chapter, the 210 million acres of tall grass east of the boundary line in fig. 25 are not considered as within the present range area.

TABLE 6.—*Depletion of virgin range in the tall-grass type, by ownership and depletion classes*

Ownership or control	Moderate depletion (0-30 percent)		Material depletion (31-50 percent)		Severe depletion (51-75 percent)		Extreme depletion (76-100 percent)		All depletion classes	
	1,000 acres	Per cent	1,000 acres	Per cent	1,000 acres	Per cent	1,000 acres	Per cent	1,000 acres	Per cent
Federal:										
National forests	302	100	0	0	0	0	0	0	302	100
Indian lands	76	72	30	28	0	0	0	0	106	100
Public domain—grazing districts	10	100	0	0	0	0	0	0	10	100
Other Federal [1]	127	100	0	0	0	0	0	0	127	100
All Federal [1]	423	98	30	7	0	0	0	0	435	100
State and county	787	100	0	0	0	0	0	0	787	100
Private	12,877	72	4,145	24	0	0	749	4	17,771	100
All ownerships	13,889	73	4,175	22	0	0	749	4	18,813	100

[1] Exclusive of 1,317,000 acres of grazable land in national parks and monuments, only 40,000 of which is actually grazed.

Included in the 73 percent of the type in reasonably good condition are the sand hills of Nebraska and the small area in the Texas Coastal Plain shown in figure 25. That so much of the type as a whole is in this condition today is undoubtedly the result of abundant rainfall coupled with the deep-rooting habit of the tall grasses and their remarkable recuperative powers. Abuse which in other range types would have quickly brought destruction has harmed the tall grass only slightly. Material forage depletion occurs in North Dakota and on part of the type in Kansas, but most of the tall-grass range in Kansas and Oklahoma, about 4 percent of the total area in tall-grass range, has lost nearly all of its former forage value.

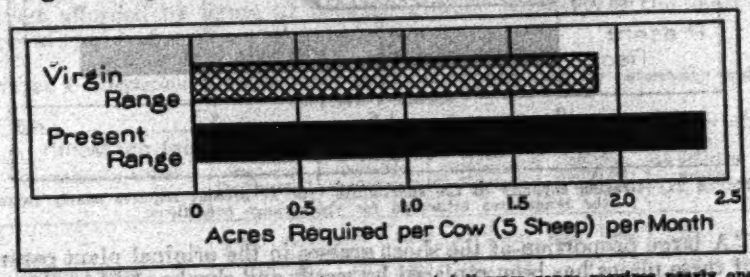


FIGURE 26.—Estimated grazing capacity on present tall-grass range requires nearly one-fifth greater area per cow (or 5 sheep) than on the virgin range.

Grazing capacity, estimated for both the virgin and the present range, as described on page 509, is shown in figure 26. In this respect, as in others, the tall-grass type has the advantage of most of the types which follow.

Although most of the tall-grass type is in reasonably good condition today, the present trend in forage values is thought to be downward on about 90 percent of the entire tall-grass range (table 25, p. 116). Unquestionably, the drought of the past few years has had a part in this decline, but drought alone has caused only about one-third of the total loss in forage grasses in this type. Overgrazing, especially during the recent drought period, is the factor chiefly

responsible. Since practically all of the tall-grass type is in private ownership, the responsibility for checking this downward trend of forage values and rebuilding the plant cover rests with the farmers and livestock operators using this range. On portions of the Nebraska National Forest the grazing capacity under controlled use has been increased 55 percent in the last 23 years, indicating the progress possible under systematic range management.

Short Grass

The short grass is the largest of the range types, covering 198 million acres (fig. 25). Of this, three-fourths is privately owned (table 5); although millions of acres plowed for agricultural crops are now reverting to public ownership for nonpayment of taxes. With many interspersed areas under various forms of Federal and State control, the short-grass type has become an enormous patchwork of farms, pasture lands, and open range upon which an increasingly complex pattern of ownership is being superimposed.

The short grasses are hardy, and this type is much less susceptible to damage through overuse than are other grass types. The forage value of the present short-grass range, however, is considerably less than that of the virgin range because of changes in the plant cover. The replacement of palatable species by inferior plants has contributed to this decline, but the major factor in range depletion has been the marked thinning of the plant cover.

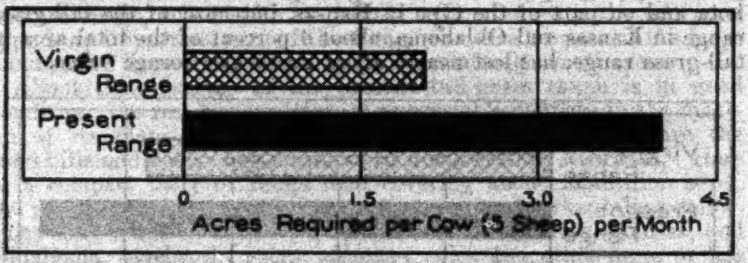


FIGURE 27.—Grazing capacity of the short-grass type at present requires nearly twice the range area estimated for virgin-range conditions.

A large proportion of the short grasses in the original plant cover of these plains has been replaced by weeds and shrubs of low palatability, such as sand sagebrush, Russian-thistle, sunflower, asters, pigweed, goldenrod, and peppergrass. In western Kansas, eastern Colorado, and southward, the worthless snakeweed, gumweed, and cactus now dominate many areas. Where mixed prairies once existed along the Arkansas River, the grasses have almost completely disappeared and sand sagebrush, Russian-thistle, and yucca now constitute 60 percent of the total plant cover. On the high plains of western Texas, weeds like Russian-thistle and broomweed comprise from 20 to 40 percent of a plant cover in which grasses once were 85 percent dominant. In eastern Colorado, grasses once comprised 86 percent of the plant cover but now constitute only 56 percent of the vegetation, whereas weeds have increased from 14 to 34 percent.

Accompanying this decrease in forage quality is the even more serious decrease in volume of forage through thinning of the entire plant cover. The vegetation in general is only half as thick as it was when the white man first began to use the range for pasturage. The recent drought is responsible for a certain amount of the thinning. It is worth noting, however, that small remnants of the short-grass range protected from grazing have nearly 10 times as thick a plant cover as adjacent areas exposed to the same drought conditions but long overgrazed by livestock.

As a result of this loss in quality and decrease in volume of vegetation, the forage value of the short-grass range is much less than that of the virgin range, and that this condition is widespread is indicated by the following figures from an extensive survey made in 1935:

Decline from original forage value:	Percent
Southwestern North Dakota	25–50
Northwestern and western South Dakota	37–43
Northeastern Colorado, western Nebraska and southeastern Wyoming	50–60
Southwest Nebraska and northwestern Kansas	50–75
Western Texas	50–70

Forage in southeastern Colorado, the "dust-bowl" area, has lost 88 percent of its former value. The forage of about 13 percent of the entire short-grass area has been extremely depleted, more than three-fourths materially or severely depleted, and only about 8 percent can be classed as being in reasonably good condition (table 7). It is significant, as shown in table 7, that of the severely and extremely depleted short-grass range more than 80 percent is privately owned. One of the best indications of what has happened is the contrast afforded by figure 27 between grazing capacity of the short-grass type now and a century ago.

TABLE 7.—*Depletion of virgin range in the short-grass type by ownership and depletion classes*

Ownership or control	Moderate depletion (0–25 percent)		Material depletion (26–50 percent)		Severe depletion (51–75 percent)		Extreme depletion (76–100 percent)		All depletion classes	
	1,000 acres	Percent	1,000 acres	Percent	1,000 acres	Percent	1,000 acres	Percent	1,000 acres	Percent
Federal:										
National forests	401	40	471	46	121	12	6	0	999	100
Indian lands	1,348	12	8,600	74	1,624	14	83	(1)	11,657	100
Public domain—grazing districts	547	6	5,181	53	3,685	39	204	2	9,718	100
Other Federal	176	5	999	19	3,400	76	0	0	5,125	100
All Federal	2,472	10	14,815	59	5,080	21	293	1	26,845	100
State and county	1,999	7	18,514	66	5,975	21	1,005	4	28,493	100
Private	11,786	8	70,961	47	41,369	28	24,607	17	148,104	100
All ownerships	16,647	8	104,290	51	54,424	26	25,901	13	203,662	100

[1] Less than 0.5 percent.

The best available information indicates that for the past quarter century about 95 percent of the whole short-grass range has steadily declined in forage value (table 24, p. 115). Nor is it likely that the present poor condition of this range marks the end of its down-

ward trend, unless more care is given the range than in the past; for depletion has been halted on only 4 percent of the type during the past 5 years and approximately 94 percent of the short-grass area is thought to be still on the downgrade (table 25, p. 116). The short-grass type, however, has remarkable recuperative powers. With favorable weather conditions and adequate care, it recovers quickly.

Pacific Bunchgrass

The Pacific bunchgrass is the most valuable grass type west of the Great Plains (fig. 25). Since settlement, however, it has lost much of its original importance because the total area of the type is smaller, and also because of a tremendous decline in the forage value of the remaining bunchgrass range.

Bunchgrass originally covered about 61,000,000 acres, but very large areas in eastern Washington and north-central Oregon have been turned to wheat production and in California much of the land which originally supported bunchgrass is now devoted to orchards and other agricultural crops. The invasion of sagebrush has still further decreased the area of the bunchgrass type, which is now estimated to be only 42.5 million acres. About 84 percent of the bunchgrass range is privately owned and most of the rest is in Federal ownership, chiefly as unreserved public domain and national forests.

Many of the valuable plants of this type have almost entirely disappeared, notably the immensely valuable bluebunch wheatgrass on large areas in eastern Oregon, Washington, Idaho, and California. Other native bunchgrasses have been largely replaced by bur-clover, "filaree", slender oat, and other plants of foreign origin. Occasionally these introduced plants have considerable forage value but they seldom compensate for the disappearance of the native vegetation. Many of the plant immigrants are worthless as feed for livestock, some are poisonous, and others are mechanically injurious, especially to lambs. Downy chess, locally called "cheatgrass", an inferior forage plant that came to this country from abroad, is of but moderate forage value for only a few weeks during the year but is now dominating large areas formerly occupied by bunchgrass. Even casual observers note the astonishingly wide distribution of Russian-thistle on the bunchgrass range.

The marked decline in forage value of the bunchgrass range can be traced in part to a general thinning of the plant cover, but chiefly to a distinct change in the character of the vegetation. Sample plots located on representative areas in Idaho, Oregon, and Washington, indicate that the outstanding feature of the change in character of the plant cover is the shift from perennial grasses to annual grasses. As shown in table 8, perennial grasses constituted approximately three-fourths of the original plant cover but form only a small portion of the present cover. Annual grasses, which were only 12 percent originally, now comprise 51 percent of the vegetation. The significance of this replacement of valuable perennial grasses by annual grasses of low palatability is at least partly reflected in the great reduction in grazing capacity of this type as shown in figure 28.

TABLE 8.—*Approximate composition of the plant cover on the bunchgrass range in Idaho, Washington, and Oregon*

Composition	Range	
	Virgin	Present
	Percent	*Percent*
Perennial grasses	76	4
Annual grasses	13	51
Weeds	10	35
Shrubs	3	10
Total	100	100

The fact that the plant cover of much of the present range is only about 60 percent as thick as that of the virgin range further explains this very considerable reduction in forage value of the bunchgrass range of today. Some parts of the present bunchgrass range are estimated to be only 30 percent as valuable for feed as under virgin conditions. For the type as a whole, as indicated by table 9, less than a tenth is only moderately depleted, whereas 55 percent is severely depleted, or worse.

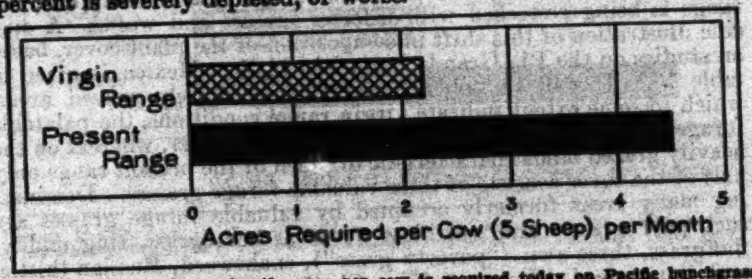


FIGURE 28.—More than twice the area per cow is required today on Pacific bunchgrass ranges that sufficed under normal conditions.

Even more alarming than the indication that nearly all the forage is gone on more than half of the bunchgrass range is the generally recognized fact that forage depletion is still continuing in this type. Recent estimates suggest that on less than one-fifth of the bunchgrass range has forage depletion been halted or the range improved (tables 24 and 25, pp. 115 and 116); and still further deterioration may be expected on the remainder.

TABLE 9.—*Depletion of virgin range in the Pacific bunchgrass type by ownership and depletion classes*

Ownership or control	Moderate depletion (0-25 percent)		Material depletion (26-50 percent)		Severe depletion (51-75 percent)		Extreme depletion (76-100 percent)		All depletion classes	
	1,000 acres	*Percent*	*1,000 acres*	*Percent*	*1,000 acres*	*Percent*	*1,000 acres*	*Percent*	*1,000 acres*	*Percent*
Federal:										
National forests	302	20	770	46	423	26	0	0	1,714	100
Indian lands	0	0	80	9	286	51	196	40	481	100
Public domain—grazing districts	0	0	220	13	573	32	991	55	1,789	100
Other Federal	0	0	306	36	360	43	196	23	862	100
All Federal	302	11	1,346	29	1,927	40	972	21	4,727	100
State and county	80	5	726	36	863	51	127	8	1,804	100
Private	2,023	8	13,891	36	17,933	50	1,603	4	35,913	100
All ownerships	2,404	8	15,963	37	20,721	48	2,727	6	43,794	100

Semidesert Grass

The chief range of the Southwest is that characterized by the nutritious grasses of the semidesert-grass type (fig. 25), which retain their palatability during the mild winters of this region. In Arizona this type is much used for winter sheep grazing; for yearling cattle grazing in Arizona and New Mexico; and for cattle, sheep, and goats in the Trans-Pecos region of Texas. More than half of its 89 million acres is in private ownership.

Most of the semidesert-grass type shows a marked loss in forage value from that of the virgin range. Three important plants—alkali sacaton, sacaton, and bush muhly ("hoe grass")—have almost entirely disappeared from the type. Gully and arroyo erosion has carved the soil from valleys that once supported magnificent stands of the sacaton grasses (*63*). Hoe grass, which now is seldom found except on areas inaccessible to livestock or as an occasional tuft under the protection of cacti and thorny shrubs, was so abundant in 1879 and 1880 that hundreds of tons were delivered as hay to Government military posts in Arizona (*12*).

As the gramas and other valuable forage grasses disappear, the range is being restocked with inferior grasses and weeds. A specific illustration of this shift in composition of the plant cover, based on studies on the Rio Grande watershed in New Mexico, is given in table 10.[9] It will be noted that on conservatively grazed areas, which to some extent indicate virgin range conditions, the palatable forage grasses comprise nearly the whole plant cover, whereas on the heavily grazed lands characteristic of much of the present range only half of the cover consists of these valuable forage grasses. Dominating many areas formerly occupied by valuable forage grasses are such poor grasses and worthless weeds as burrograss, ring muhly, fluffgrass, three-awn ("poverty grass"), snakeweed, Russian-thistle, and jimmyweed ("burroweed"). Cholla cactus has invaded many square miles in central Arizona and on former grasslands creosotebush is encroaching. Drymaria, a deadly poisonous species, has increased on overgrazed clay flats in New Mexico, and in southwest Texas, bitter rubberweed, which also is poisonous, has appeared in many places (*30, 84*). In New Mexico, as the valuable black grama disappears the range gradually becomes more and more an essentially worthless mesquite-sand-dune shrub type (*29*).

TABLE 10.—*Approximate composition of herbaceous cover on a semidesert-grass range in New Mexico*

Composition	Conservatively grazed lands	Heavily grazed lands
	Percent	*Percent*
Good grasses (black grama, blue grama, side-oats grama)	85	50
Poor grasses (ring muhly, dropseed, three-awn)	6	10
Weeds and shrubs	9	40
Total	100	100

[9] Cooperrider, C. K., and Hendricks, B. A. Soil Erosion and Streamflow in Relation to Land Resources and Human Welfare on the Upper Rio Grande Watershed. U. S. Dept. Agr. Tech. Bull. (In process of publication.)

A valuable forage plant which has come into the semidesert type is alfileria, or "filaree." This plant appeared in the 1870's (*143*) and is excellent feed in wet years, but since in this type it occurs in abundance only in southern Arizona and produces a good crop of feed only in occasional years, it does not fully compensate for the loss of perennial grasses which it is replacing.

In addition to the loss of valuable forage plants, the plant cover of the present semidesert-grass range is thinner. For example, on the upper Rio Grande watershed in New Mexico it is estimated to be only about 40 percent as thick as that of the virgin range. Other studies on representative areas in the Trans-Pecos region of western Texas also indicate that the plant cover on many present ranges is scarcely 40 percent as thick as that on ungrazed areas in the same region.

As a result of this marked thinning of the plant cover and the widespread loss of valuable forage plants, the value of the semidesert range for feed has diminished greatly. Fully two-thirds of

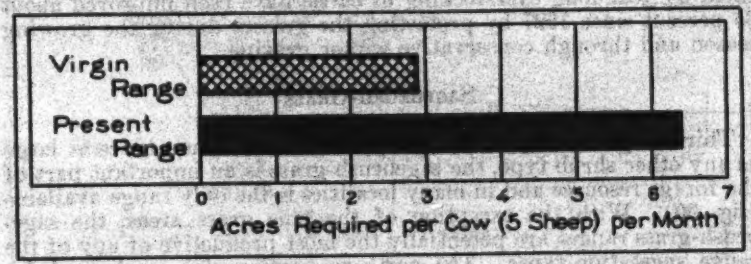


FIGURE 29.—Because of the serious loss in grazing capacity in the semidesert-grass type, nearly 6½ acres is required per cow where 3 acres once furnished ample feed.

the semidesert range has less than half the forage value it once possessed (table 11) and, as a whole, this range is one of the most severely depleted range types of the entire West, as indicated by the grazing-capacity comparison in figure 29.

TABLE 11.—*Depletion of virgin range in the semidesert-grass type by ownership and depletion classes*

Ownership or control	Moderate depletion (0 to 25 percent)		Material depletion (26 to 50 percent)		Severe depletion (51 to 75 percent)		Extreme depletion (76 to 100 percent)		All depletion classes	
	1,000 acres	Percent	1,000 acres	Percent	1,000 acres	Percent	1,000 acres	Percent	1,000 acres	Percent
Federal:										
National forests	50	3	900	60	470	28	307	19	1,727	100
Indian lands	163	1	570	5	11,197	91	415	3	12,325	100
Public domain—grazing districts	100	1	2,252	31	3,967	53	1,200	16	7,519	100
Other Federal	0	0	100	4	2,328	91	406	16	2,734	100
All Federal	312	1	3,841	16	17,962	73	2,304	10	24,429	100
State and county	305	2	6,806	43	9,084	55	214	1	16,440	100
Private	1,699	3	14,951	30	30,447	62	1,718	4	48,835	100
All ownerships	2,317	3	25,598	28	57,393	64	4,236	5	89,274	100

Aside from loss in forage values, the deterioration of the plant cover has permitted the occurrence of destructive floods. Investiga-

tions in Arizona disclosed that thinning of the plant cover increased run-off of summer rains and greatly accelerated the rate of soil loss. One of a pair of lysimeter study plots, for example, had 51 percent less grass cover than the other and on this plot the run-off of summer rainfall was 46 percent greater and the rate of soil loss almost 500 percent greater than on the adjoining plot with the thicker plant cover.

The trend of range depletion is estimated to be downward on about 90 percent of the semidesert-grass type (table 24, p. 115). The most serious situation at present is on areas of long-established use as in the Pecos, Rio Grande, Gila, and Santa Cruz Valleys where prompt action must be taken to save these ranges. Although this type is very susceptible to damage by overgrazing, and climatic conditions make recovery slow and difficult, experience on the Tonto National Forest in central Arizona proves that if forage depletion and soil erosion are not too far advanced, depleted ranges can be restored. On this forest, certain semidesert-grass ranges deteriorated by year-long overstocking of cattle have been improved about 35 percent since 1927 by protecting the grasses during the growing season and through conservative winter grazing.

Sagebrush-Grass

Third largest of all the range types and more than twice as large as any other shrub type, the sagebrush-grass is an important part of the forage resource and in many localities is the only range available (fig. 30). With the exception of the true grass areas, the sagebrush-grass ranges are potentially the most productive of any of the range vegetation types. The northern portions are much used for spring-fall range, and, because stockmen are dependent upon it for feed in those seasons, it forms an indispensable link between the winter and summer ranges.

The 96.5 million acres now in this type include an increase of about 6.5 million acres beyond the area occupied under virgin conditions. This increase in area has been at the expense of bunchgrass in the Pacific Northwest and short grass in Wyoming. Locally many grass meadows also have been invaded by sagebrush. Thousands of acres of sagebrush lands have been turned to crop agricultural purposes, especially where irrigation was possible, but the greater portion of the type still remains open range. Nearly half of the total area used as range is open public domain, and over a third is privately owned.

In its original condition the sagebrush range consisted of a rather sparse cover of sagebrush beneath which was a rich stand of palatable perennial grasses and weeds. Today the sagebrush has thickened greatly and in parts of Oregon, for example, has increased more than 60 percent. The palatable perennial grasses and weeds, however, have almost entirely disappeared. Perennial grasses on the Snake River Plains of Idaho are only one-fourth, and on representative areas in Oregon but half as thick as on remnants of the virgin range. The grass cover on sagebrush lands in central Nevada is only 10 percent, in northern Nevada 24 percent, and in western Utah 36 percent as thick as formerly. Over a large part of the type practically the only feed left for livestock is the very inferior sagebrush itself.

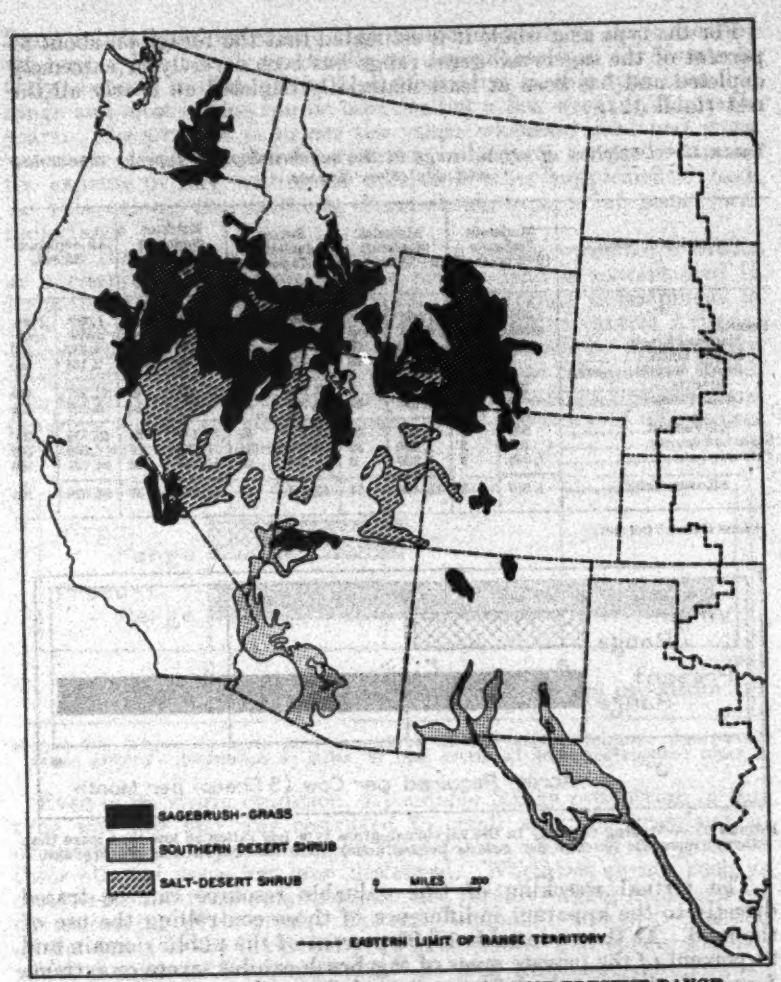


FIGURE 30.—THE PRINCIPAL SHRUB TYPES OF THE PRESENT RANGE.

Much of the southern desert-shrub type in the contiguous portions of California and Arizona is omitted, since these areas are virtually ungrazable.

It is this tremendous loss of forage grasses and weeds that has brought about the present low grazing capacity indicated in figure 31. It is estimated that grazing capacity in different parts of the type is 60 to 90 percent less than it was in pioneer days, as shown below:

Decline from virgin forage value:	Percent
Southern Idaho	68
Eastern Oregon	65
Colorado and Wyoming	60–70
Western Colorado (badly depleted public domain)	80
Northern Nevada	71
Western Utah	60

For the type as a whole it is estimated that the forage on about 84 percent of the sagebrush-grass range has been severely or extremely depleted and has been at least materially depleted on nearly all the rest (table 12).

TABLE 12.—*Depletion of virgin range in the sagebrush-grass type by ownership and depletion classes*

Ownership or control	Moderate depletion (0-25 percent)		Material depletion (26-50 percent)		Severe depletion (51-75 percent)		Extreme depletion (76-100 percent)		All depletion classes	
	1,000 acres	*Percent*	*1,000 acres*	*Percent*	*1,000 acres*	*Percent*	*1,000 acres*	*Percent*	*1,000 acres*	*Percent*
Federal:										
National forests	417	11	2,455	66	783	20	33	1	3,687	100
Indian lands	7	(1)	1,613	75	470	22	60	3	2,150	100
Public domain—grazing districts	222	1	2,889	6	23,960	53	17,827	40	44,897	100
Other Federal	0	0	3,261	41	3,706	44	910	15	6,147	100
All Federal	656	1	9,107	16	28,882	49	19,848	34	56,179	100
State and county	105	2	2,469	38	2,704	41	1,369	19	6,648	100
Private	1,058	3	1,920	6	15,070	46	15,727	45	34,701	100
All ownerships	1,819	2	13,496	14	45,646	47	35,583	37	96,528	100

[1] Less than 0.5 percent.

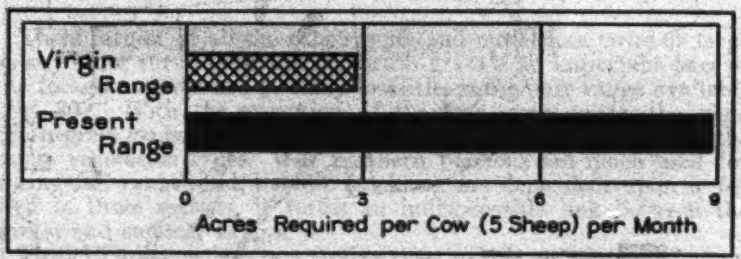


FIGURE 21.—Grazing capacity in the sagebrush-grass type has fallen so low that more than three times the acreage per cow is needed today that was required a century ago.

The virtual wrecking of this valuable resource can be traced directly to the apparent indifference of those controlling the use of the land. As shown in table 12, 93 percent of the public domain and 91 percent of the private areas of sagebrush exhibit severe or extreme forage depletion. And 81 percent of the entire sagebrush type is in these two ownerships.

Although the forage of this type already is greatly depleted, still further deterioration can be expected, for estimates based on detailed studies over a large part of the sagebrush-grass range indicate that on about 90 percent forage depletion is continuing (tables 24 and 25, pp. 115 and 116). Only immediate and drastic changes in existing policies for handling grazing on these ranges will prevent destruction of the remaining forage.

SOUTHERN DESERT SHRUB

The southern desert-shrub type (fig. 30) has been of less importance than other types in the development of the range industry.

Scant rainfall and extremely high temperatures have made most of the type a desert with practically no dependable feed for livestock. Only about 27 million of the 51 million acres in this type is usable range and most of this can be used for but a few weeks in favorable years. The practice is to use the range whenever feed and stock water are available, thereby reserving adjoining ranges or saving the expense of hay, cottonseed cake, and other supplemental feed. To this extent, the southern desert-shrub type is of some local importance.

More than half of the type is still in public ownership, chiefly as unreserved public domain. The private land is concentrated in irrigation projects such as the lower Rio Grande development in New Mexico, and the Salt River Valley project of central Arizona. Many attempts have been made to raise livestock in the southern desert-shrub type, but without irrigation these have often failed. The sagging ruins of windmill towers and the sunbleached boards of tumbling shacks are all that remain to tell the story of efforts that quickly destroyed themselves.

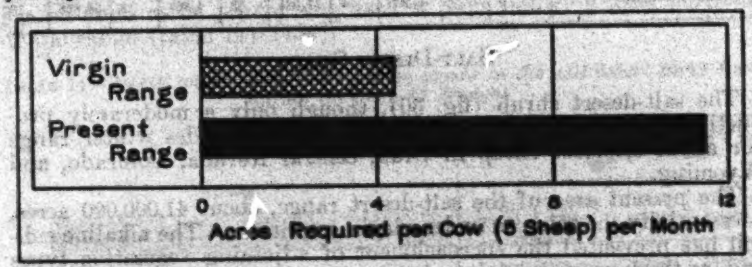


FIGURE 32.—Where 4½ acres per cow sufficed on the original southern desert-shrub range, grazing capacity has so fallen off that nearly 12 acres are required today.

Even in its virgin condition, dependable forage production in this type was low and was restricted to small areas of grassland in drainage ways, depressions, and flood plains. Most of the grass on these alluvial areas has been destroyed. Worthless shrubs such as creosotebush, tarbush, and mesquite are rapidly taking possession of the remaining grass areas. The only abundant forage production of the desert is the luxuriant growth of winter and spring annuals which flourish in favorable years. At such times, alfileria, Indian-wheat, bur-clover, milkvetch, and sixweeks fescue carpet the desert valleys. Most important of all is alfileria, which appeared about 1870 along the freighting and stage routes in southern Arizona.

Examinations on the Rio Grande watershed indicate that near the upper limits of the type the original plant cover was composed of grasses and of weeds and browse in the ratio of about 4 to 1, whereas the plant cover of the present range in that locality now has 77 percent weeds and browse and only 23 percent grass. Moreover, the cover of the present range is only about one-third as thick as that of the virgin range. The result, as expressed in grazing capacity, is a great loss in range values, as shown in figure 32.

About 81 percent of the usable southern desert-shrub range is severely or extremely depleted (table 13). On the relatively small

accessible grazing area of the type, forage depletion has proceeded so far, and climatic conditions are so severe, that restoration of the range will be exceedingly difficult and very slow.

TABLE 13.—*Depletion of virgin range in the southern desert-shrub type by ownership and depletion classes*

Ownership or control	Moderate depletion (0-25 percent)		Material depletion (26-50 percent)		Severe depletion (51-75 percent)		Extreme depletion (76-100 percent)		All depletion classes	
	1,000 acres	*Per cent*	*1,000 acres*	*Per cent*	*1,000 acres*	*Per cent*	*1,000 acres*	*Per cent*	*1,000 acres*	*Per cent*
Federal:										
National forests	0	0	50	51	8	8	40	41	98	100
Indian lands	0	0	0	0	2,331	97	75	3	2,406	100
Public domain—grazing districts	0	0	1,362	21	3,894	60	1,467	23	6,424	100
Other Federal	0	0	0	0	1,300	85	230	15	1,530	100
All Federal	0	0	1,412	14	7,533	69	1,815	17	10,461	100
State and county	0	0	1,282	23	4,200	74	240	4	5,722	100
Private	0	0	2,342	22	5,548	53	2,752	26	10,642	100
All ownerships	0	0	5,036	19	17,081	63	4,807	18	26,826	100

SALT-DESERT SHRUB

The salt-desert shrub (fig. 30), though only a moderately productive range type, is important because it provides winter range for about 6,000,000 sheep in Utah, central Nevada, Colorado, and Wyoming.

The present area of the salt-desert range, about 41,000,000 acres, is essentially the same as under virgin conditions. The alkaline subsoil has prevented the encroachment of adjoining vegetation types and, as the low productivity of the soil and the scanty rainfall have discouraged settlers from utilizing the land for crops, most of the salt-desert type is still used as open range. Ownership, as in the virgin range, rests largely with the Federal Government as unreserved public domain.

Although the salt-desert-shrub type has changed but little in area or ownership, it is by no means in its virgin forage condition. Some of the main forage plants have almost disappeared from the type and have been replaced by unpalatable species. The extermination of valuable grasses and shrubs and their replacement by inferior species is especially evident on some of the valley plains. Here on the somewhat damper soils of the bottomlands, the once abundant giant wild-rye has been almost entirely replaced by nearly worthless greasewood. On the much more extensive, drier, and less saline soils of the valley plains the valuable ricegrass and dropseed have been so extensively killed out that they probably can be restored only by artificial reseeding. Except for a few fringes, vast areas of the palatable and nutritious winterfat, or "whitesage", have been replaced by shadscale and little rabbitbrush. In the Red Desert region of southwestern Wyoming the almost worthless rabbitbrush and snakeweed have displaced valuable forages on large tracts and are rapidly

dominating many other parts of the range. Thus, while remnants of the virgin range have an average of only 59 rabbitbrush and 41 snakeweed plants per 2,000 square feet, heavily grazed areas of the present range have 193 rabbitbrush and 196 snakeweed plants per 2,000 square feet of range, or virtual domination of the plant cover by these worthless species.

Besides having a smaller proportion of valuable forage plants, the plant cover on the salt-desert ranges is thinner now than in pioneer days. An analysis of over 1,700 sample plots indicates that the plant cover of the present range averages in western Utah only 55 percent, in central Nevada 78 percent, and in southwestern Wyoming about 67 percent as dense as that on small remnant areas of virgin or lightly grazed ranges.

The recent drought is responsible for a part of the current reduction in plant density but is not as serious a factor in range depletion as is commonly assumed. Investigations in southwestern Wyoming and in western Utah show conclusively that during the 1931–35 drought from 3 to 10 times as many plants have died on heavily grazed areas as on nearby ungrazed or very lightly grazed portions of the range (table 14) (*136*).

TABLE 14.—*Death losses of valuable forage plants in the salt-desert-shrub type during the 1931–35 drought*

Species	Western Utah		Southwestern Wyoming	
	Lightly grazed	Heavily grazed	Lightly grazed	Heavily grazed
	Percent	*Percent*	*Percent*	*Percent*
Ricegrass	24	89	11	31
Winterfat	11	67	5	40
Bud sagebrush			2	30
Nuttall saltbush				

Forage values, because of these several aspects of plant depletion, have shrunk greatly in the salt-desert-shrub type. The average forage values on Nevada ranges are estimated to be only 49 percent of those on areas protected from grazing; in Utah, 36 percent; and in southwestern Wyoming, 43 percent. Resident stockmen who have operated from 12 to 55 years on this range type estimate that the present open range is as much as 80 percent less valuable as forage than it was half a century ago. Of the 41 million acres in the salt-desert-shrub type, almost 90 percent has less than half the forage value of the virgin salt-desert range (table 15). The relation of land ownership to the status of range depletion in the salt-desert type is clearly indicated in this table. It is significant that 75 percent of the type is public domain and that 90 percent of the public-domain area is severely or extremely depleted. Grazing capacity in this type has been reduced relatively more than in any of the other types, as indicated in figure 33.

TABLE 18.—*Depletion of virgin range in the salt-desert-shrub type, by ownership and depletion classes*

Ownership or control	Moderate depletion (0-25 percent)		Material depletion (26-50 percent)		Severe depletion (51-75 percent)		Extreme depletion (76-100 percent)		All depletion classes	
	1,000 acres	Percent	1,000 acres	Percent	1,000 acres	Percent	1,000 acres	Percent	1,000 acres	Percent
Federal:										
National forests	181	49	178	49	7	2	0	0	366	100
Indian lands	3	(1)	709	43	894	54	50	3	1,657	100
Public domain—grazing districts	0	0	3,157	10	13,676	45	13,824	45	30,657	100
Other Federal	25	1	125	6	200	10	1,650	83	2,000	100
All Federal	211	1	4,169	13	14,977	47	15,524	49	34,680	100
State and county	0	0	21	2	259	27	666	71	927	100
Private	61	1	149	3	2,374	45	2,677	51	5,261	100
All ownerships	271	1	4,339	10	17,601	43	18,867	46	40,868	100

[1] Less than 0.5 percent.

During the past 30 years the forage values on over 85 percent of the type have been declining, and the present trend also is downward (tables 24 and 25, pp. 115 and 116). As indicated in table 25, only 1 percent of the type is exhibiting any appreciable improvement in forage values.

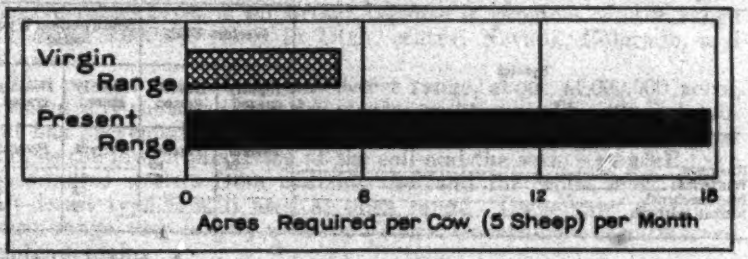


FIGURE 33.—The greatest falling-off in grazing capacity is to be found in the salt-desert-shrub type, where more than three and one-half times the acreage per cow is now required.

PIÑON-JUNIPER

The piñon-juniper type extends as far north as south-central Oregon, but is of value for forage mainly in Arizona, New Mexico, and southern Colorado (fig. 34). It is much used for spring-fall range and in some places as winter range, for which it is valuable because its grasses cure naturally on the stalk and because the trees afford protection to livestock.

There has been very little change in the total area of the piñon-juniper type during the past century. The rocky slopes and flat-topped mesas on which it is commonly found are not adapted to crop agriculture, and very little of the original piñon-juniper type has been diverted to agricultural crops. Three-fourths of the 76 million acres in the present piñon-juniper range is divided among public domain, national forests, and private holdings.

On two-thirds of this type the forage is either materially or severely depleted, and on an additional fourth it is extremely depleted (table 16). This loss in forage value probably has resulted

from a general thinning of the herbaceous cover rather than from extensive changes in its composition. For example, on piñon-juniper ranges of the upper Rio Grande watershed in New Mexico, grasses which originally made up about 80 percent of the herbaceous cover still hold this position, except on the most severely depleted areas.

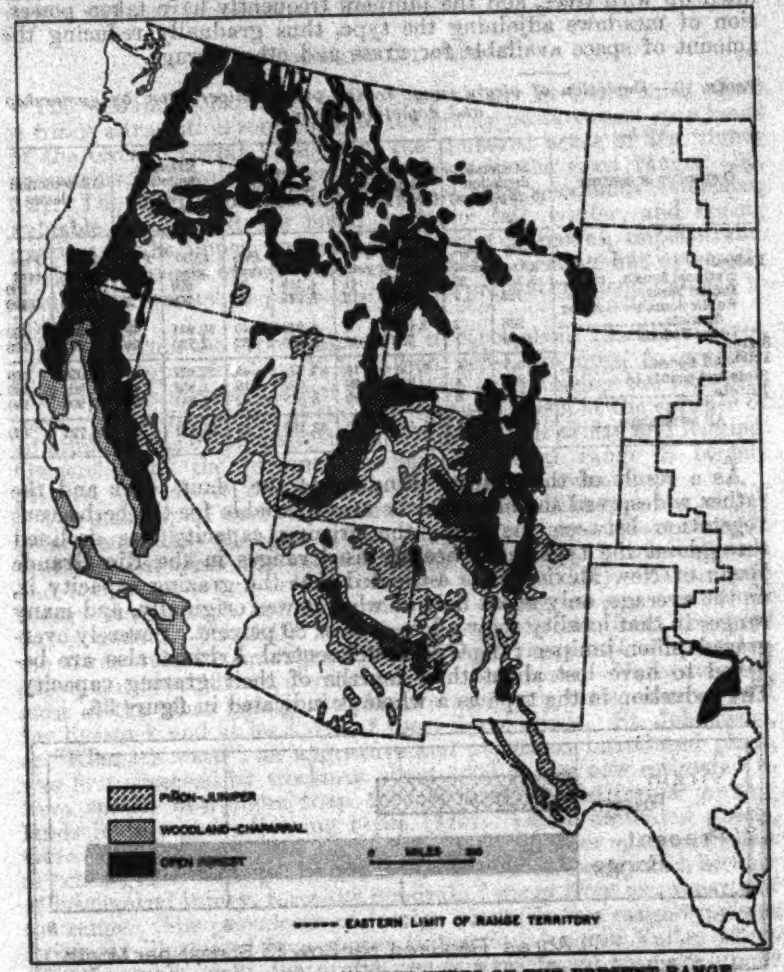


FIGURE 34.—THE PRINCIPAL FOREST TYPES OF THE PRESENT RANGE.

Much of the open-forest type is on the national forests. Woodland-chaparral is wholly a California type.

The average density of this herbaceous vegetation, however, is in that region less than half what it was in the virgin condition. The more northerly piñon-juniper ranges probably had a thin cover of herbaceous vegetation even before the white man began to use those ranges and, with long-continued and excessive use, the forage plants

have practically vanished from many portions of the type in Nevada, Utah, and Oregon. There is also little doubt that the general thickening of the tree stand throughout the type has still further reduced the area which can be occupied by herbaceous plants. Many of the small grassy "parks" characteristic of the type have filled up with trees, and the junipers frequently have taken possession of meadows adjoining the type, thus gradually reducing the amount of space available for grass and other forage.

TABLE 16.—*Depletion of virgin range in the piñon-juniper type, by ownership and depletion classes*

Ownership or control	Moderate depletion (0-25 percent)		Material depletion (26-50 percent)		Severe depletion (51-75 percent)		Extreme depletion (76-100 percent)		All depletion classes	
	1,000 acres	Per cent	1,000 acres	Per cent	1,000 acres	Per cent	1,000 acres	Per cent	1,000 acres	Per cent
Federal:										
National forests	3,462	25	5,681	41	4,189	30	599	4	13,811	100
Indian lands	122	1	1,946	13	8,214	80	738	7	10,369	100
Public domain—Grazing districts	328	2	3,622	9	8,948	40	10,934	49	23,832	100
Other Federal	85	1	800	8	1,800	33	2,750	50	4,981	100
All Federal	4,017	3	9,151	18	22,831	45	15,037	30	51,036	100
State and county	238	3	1,648	25	4,622	18	1,853	29	8,362	100
Private	1,683	8	6,333	30	8,675	43	4,241	20	20,000	100
All ownerships	5,978	8	16,441	23	32,188	43	21,131	28	75,728	100

As a result of the general thinning of the plant cover and the rather widespread shrinkage in the area available for the herbaceous vegetation between the trees, the grazing capacity has declined throughout the type. On heavily used ranges in the Rio Grande Basin of New Mexico, it is estimated that the grazing capacity is, on the average, only about half of what it was originally, and many ranges in that locality show a loss of over 80 percent. Severely overgrazed piñon-juniper ranges in south-central Arizona also are believed to have lost about three-fourths of their grazing capacity. The reduction in the type as a whole is indicated in figure 35.

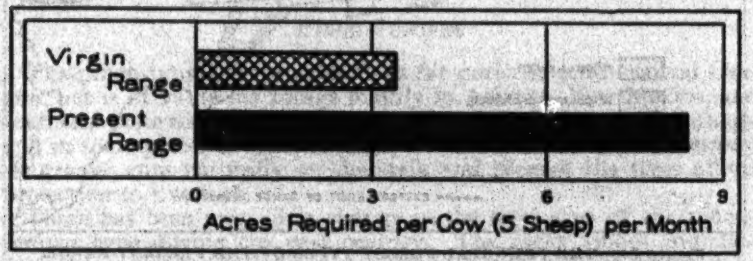


FIGURE 35.—Estimated grazing capacity of the piñon-juniper type under virgin-range conditions has been reduced by more than half.

The most widespread and serious forage depletion in the piñon-juniper type is, as shown in table 16, on the public domain, Indian lands, and privately owned ranges. Under these three forms of control more than half of the entire area of the piñon-juniper type has lost from 50 to 100 percent of its forage value.

This reduction in forage values is not a recent development. During the last 25 or 30 years nearly three-fourths of the piñon-juniper type has steadily deteriorated as a forage resource (table 24, p. 115). During this period scarcely one-fifth of the total area in the type has shown any improvement whatever, and practically all of this is on the national forests of the Southwest.

Woodland-Chaparral

The woodland-chaparral type occurs chiefly in California, where it forms a transition zone between the grassy pastures and crop lands of the Great Central Valley and the timbered areas of the higher mountains; it also covers extensive areas in the coast ranges (fig. 34.) The lower portions of this type are open woodlands containing valuable forage and are much used for fall, winter, and spring grazing. The upper portions are mostly chaparral, impenetrable thickets of brush of low value or unfit for grazing but extremely valuable in watershed protection and in preventing flood damage to lower areas.

In California the type is estimated to cover about 19 million acres, of which approximately 13.4 million acres are open to grazing. The type has increased about 3.5 million acres during the past century. About 70 percent of this expansion has been at the expense of adjoining areas of commercial timber, as a result of fire and logging. Ownership of the present woodland-chaparral range is largely private, only about 20 percent being in public ownership.

The make-up of the herbaceous plant cover in this type has undergone tremendous changes within the past century. More than 30 years ago, at least one valuable forage plant, California oatgrass, had become scarce in certain parts of the type (*42*). Other good forage plants, such as needlegrass and oniongrass are now much less abundant. Partially replacing the plants lost from the type are three valuable immigrants which have appeared in considerable quantity: Alfileria, slender oat, and bur-clover. Unfortunately, most of the other immigrant plants are of very little value as feed for livestock and at least one of them is poisonous. St. Johnswort, or "Klamath weed", an aggressive and poisonous introduced plant, was first observed by stockmen about 1900 and is now estimated to have spread over more than 100,000 acres of California grazing lands in this and adjoining types (*117*). Other uninvited guests, more especially foxtail chess, ripgut grass, and other species of chess or "cheatgrass" having stiff beards (awns), mature early and, because of mechanical injury, force the removal of sheep from many parts of the range. The prevalence of foreign plants in this range type was strikingly illustrated by a survey in the San Joaquin Valley where on 907 sample plots, the exotic plants were found to make up 59 percent of the plant cover in the woodland portions of the type and 51 percent in the chaparral.

Extensive replacement of good forage plants by species of little or no forage value has occurred throughout the type. On a small ungrazed area near Sonora, Calif., it was found that 95 percent of the grasses and herbs originally present were palatable and nutritious, whereas only 36 percent of the grasses and herbs on adjacent grazed areas are suitable for feed (table 17). A survey in the

woodland portion of the type in the San Joaquin Valley gave still further evidence of the replacement of valuable perennials by inferior annual grasses and weeds: Sample plots on ungrazed areas there have an average of about 69 percent perennial and 31 percent annual plants, but plots on typical nearby grazed areas indicate that the herbaceous vegetation of the present range has only 2 percent perennials but 98 percent annuals.

The herbaceous plant cover is, over most of the type, as thick now as it was before the range was used by domestic livestock. As has been noted, new plants have come into the type in sufficient numbers to replace completely those which have disappeared. Even though the herbaceous cover is as thick as formerly, however, the total area available for grazing is smaller because existing brush thickets have expanded and new ones have appeared. Thus, the decline in grazing capacity shown in figure 36 is attributable both to the smaller percentage of valuable forage plants and to the smaller area available for forage production.

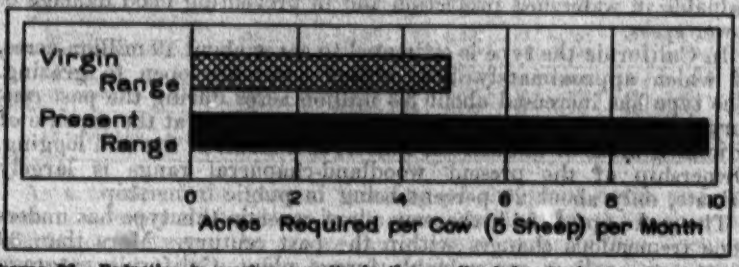


FIGURE 36.—Reduction in grazing capacity in the woodland-chaparral type since pioneer days is estimated at 50 percent.

TABLE 17.—*Approximate composition of the herbaceous cover on virgin and present ranges in the woodland-chaparral type*

Composition	Small remnant of the virgin range	Present (grazed) range
	Percent	Percent
Perennial grasses (good forage)	50	0
Annual grasses and herbs:		
Good forage	5	32
Poor or worthless forage	5	68
Total	100	100

It is estimated that the forage is severely depleted on fully one-half of the present woodland-chaparral range, and at least materially depleted on the remainder (table 18). Moreover, depletion is continuing on about three-fourths of the type (tables 24 and 25). This depletion results chiefly from the grass and brush fires which sweep across the foothill country. Woodland-chaparral ranges in all ownerships have suffered alike from fire. Even though most of these ranges are privately owned, high watershed and wildlife values of the type are of great public importance and concerted public and private action is needed to exclude fire from the woodland-chaparral ranges.

TABLE 18.—*Depletion of virgin range in the woodland-chaparral type by ownership and depletion classes*

Ownership or control	Moderate depletion (6-30 percent)		Material depletion (31-50 percent)		Severe depletion (51-75 percent)		Extreme depletion (76-100 percent)		All depletion classes	
	1,000 acres	Percent	1,000 acres	Percent	1,000 acres	Percent	1,000 acres	Percent	1,000 acres	Percent
Federal:										
National forests	13	2	609	78	300	38	0	0	712	100
Indian lands	0	0	72	92	6	8	0	0	78	100
Public domain—grazing districts	0	0	726	47	827	53	0	0	1,553	100
Other Federal	6	0	66	30	80	70	0	0	130	100
All Federal	19	(1)	1,433	35	1,163	45	0	0	2,603	100
State and county	0	0	30	31	68	69	0	0	108	100
Private	140	1	4,836	45	5,469	52	174	2	10,640	100
All ownerships	163	1	6,327	46	6,732	50	174	1	13,396	100

[1] Less than 0.5 percent.

OPEN FORESTS

Open forests are a prominent part of the grazing resource. These forests of more or less widely spaced trees with intermingled grassy meadows and browse thickets comprise the second largest (126 million acres) of all the range types (fig. 34) and the most widely distributed. It includes such diverse forms as nearly pure stands of ponderosa pine, ponderosa pine with sugar pine or Douglas fir, aspen and fir, spruce and fir, alpine grasslands, and mountain brush. Much of it occurs on steep hillsides. Although used to some extent as spring-fall range, the open-forest type is preeminently a summer range. Much of it lies at high altitudes where the snow remains late in the spring and forage generally does not become available to livestock as early as in other range types. Portions of the type which lie at lower elevations ordinarily are used for spring-fall range.

Of the 126 million acres of open-forest range, about half is in large blocks under national-forest supervision and a little more than a third is in much smaller, more widely scattered privately owned units.

Forage depletion in the open-forest type has resulted, as in other range types, from the replacement of good forage plants by poor ones, and from a general thinning of the herbaceous cover. In addition, the development of dense thickets of young trees or brush, desirable as this may be for timber production or watershed protection, has reduced the area available for forage plants.

The most serious forage depletion is on the numerous grassy meadows scattered through the type, which, though relatively small in total area, formerly had a very large part of the best forage. Replacement of palatable species by plants of inferior grazing value is especially evident here. On representative forest meadows in Oregon and Washington where tufted hairgrass originally was 90 percent of the ground cover, it is now only 50 percent, having been replaced by dandelion, knotweed, and senecio. In the ponderosa pine forests of the Coconino Plateau in Arizona, grasses are 90 percent and unpalatable weeds 2 percent of the herbaceous cover on lightly grazed meadows, whereas on heavily grazed areas grasses are

only 10 percent and unpalatable weeds 75 percent of the cover. On some forest meadows of Montana, redtop, alpine bluegrass, sheep fescue, oatgrass, gentian, and alpine willows have dwindled in numbers, giving way to weeds of low palatability. In the ponderosa pine forests of Montana and northern Idaho it is reported that such forage grasses as wheatgrass, Idaho fescue, and bluegrass are scarcer, and that downy chess ("cheatgrass") and inferior weeds are increasing. In the Southwest, mountain-mahogany, cliffrose, and other highly palatable browse species are being replaced in many places by the much less palatable manzanita and skunkbush.

Likewise the greatest changes in the density of the herbaceous cover have occurred in the forest meadows, "parks", and alpine grasslands. Cattle congregate on such areas and, because feed is more abundant and herding easier, it is difficult to prevent overuse by sheep. In some parts of the ponderosa pine forests of northern Arizona it is estimated that the herbaceous cover on these mountain parks is only 45 percent as thick as on similar areas where livestock have not congregated. An analysis of results obtained by measuring the herbaceous cover on nearly 1,200 plots in the open forests and mountain meadows of Colorado and Wyoming indicates the following reductions in density of plant cover:

Reduction from density of virgin range:	Percent
Open lodgepole pine	11
Ponderosa pine	21
Alpine meadows	34
Aspen forests	45
Oak brush	45

In some parts of the type the density of the herbaceous cover has been reduced to practically nothing through development of dense thickets of pine reproduction. These thickets vary from a few square feet to several acres in size and effectively shade out the herbaceous plants. Thus, although the total acreage classified as open-forest type may remain constant, the net area available for forage plants may be considerably smaller. On the Sitgreaves National Forest in Arizona, it is estimated that the development of dense pine thickets on some parts of that forest has been an important factor in reducing the grazing capacity of that range fully 25 percent in the last 20 years. Dense thickets of young pine trees frequently occur on logged-over areas of ponderosa pine forests and reduce the amount of space available for forage production as do similar thickets in the uncut forests. Expansion of brush on logged-over areas also materially decreases the space available for herbaceous plants. A notable example is the 10-mile advance on a 30-mile front of chaparral thickets on cut-over pine lands in Eldorado County, Calif. (*184*). These trees and brush thickets are, however, highly desirable for maintenance of the timber supplies and for watershed protection and it should also be appreciated that the loss in forage may be merely temporary while the trees are attaining maturity.

The net result of increased numbers of inferior species, less density of vegetation, and the incursion of thickets is expressed in the reduced grazing capacity shown in figure 37.

Forage conditions on the open-forest range as a whole are better than in any other type except the tall-grass (table 21, p. 111). But these conditions vary widely with ownership. As shown in table 19, forage depletion has reached an advanced stage under some forms of ownership or land management. About one-half of the type is in the national forests, and a majority of the national-forest ranges have less than 25-percent forage depletion. Forest ranges under other forms of Federal control are, as shown in table 19, largely de-

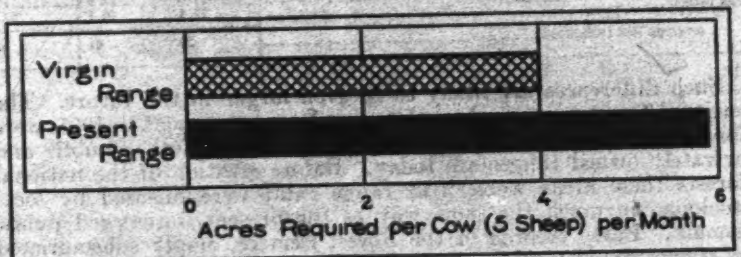


FIGURE 37.—Estimated original and present grazing capacity in the open-forest type, where nearly half again the range area per animal unit is now required.

pleted materially or worse. About one-fourth of the privately owned forest ranges and about the same proportion of State and county lands in this type are in reasonably good condition.

TABLE 19.—*Depletion of virgin range in the open-forest type by ownership and depletion classes*

Ownership or control	Moderate depletion (0–25 percent)		Material depletion (26–50 percent)		Severe depletion (51–75 percent)		Extreme depletion (76–100 percent)		All depletion classes	
	1,000 acres	Percent	1,000 acres	Percent	1,000 acres	Percent	1,000 acres	Percent	1,000 acres	Percent
Federal:										
National forests	25,670	55	26,240	57	4,412	7	524	1	64,795	100
Indian lands	1,441	20	4,427	62	1,186	16	186	2	7,180	100
Public domain—grazing districts	861	12	749	17	3,194	51	811	19	4,295	100
Other Federal	100	6	857	49	773	44	9	1	1,739	100
All Federal	37,792	48	32,272	39	9,621	11	1,280	2	78,049	100
State and county	1,289	26	2,251	44	1,168	23	315	7	4,750	100
Private	12,116	28	20,158	46	9,073	21	2,191	5	43,538	100
All ownerships	51,196	40	53,681	42	18,711	15	3,827	3	126,367	100

The close connection between ownership and degree of forage depletion is illustrated by a recent survey in the open forests of Colorado, Wyoming, and the Black Hills of South Dakota. Detailed studies on nearly 1,200 sample plots (table 20) indicate that the average loss in forage values from virgin forage conditions is as follows: Lands under national-forest management, 25 percent; privately owned ranges, 41 percent; and public domain, 63 percent. It should be noted that these average relationships also hold for smaller portions of the type, indicating that form of management rather than local variation in the type itself is responsible for these large differences in forage depletion.

TABLE 20.—*Decline in range forage value as related to ownership (or control) of range lands in the open-forest type in Colorado, Wyoming, and South Dakota*

Type	National forest	Private	Public domain
	Percent	*Percent*	*Percent*
Ponderosa pine	21.8	28.2	
Alpine meadows	28.2	32.6	
Aspen forests	31.6	71.9	
Oak brush	17.4	56.7	62.3
Average loss (weighted)	25	41	62

Such differences are likely to be even larger in the future. The national-forest ranges, when placed under management in 1905, were for the most part in about the same condition as other public and privately owned ranges are today. Before creation of the national forests these areas were "free range" and were misused by local stockmen in much the same way as the present unreserved public domain. Early records of the Forest Service, amply substantiated by statements of local residents, describe many national-forest ranges in this type as being little better than "dust beds" almost devoid of forage plants. Although these national-forest ranges are not yet restored to full grazing capacity, the remarkable improvement which has been obtained during the past 30 years proves that with systematic management the remaining open-forest ranges now in poor condition can be reclaimed. It is estimated that nearly 60 percent of the open-forest type has shown appreciable improvement during the past quarter century but that the forage values on about 25 percent are being still further decreased (table 24, p. 115). During the past 5 years, as shown in table 25 (p. 116), the recent unprecedented drought (abetted probably by other factors) has caused a temporary shift in trends, and only about 35 percent of the open-forest ranges are at present thought to be improving in forage value.

UNGRAZED AREAS

Of the 974,548,480 acres gross area of the present western range country, over 245 million cannot be used for grazing. Of these, 68 million acres are in dense forests;[10] 116 million acres in farms; slightly over 2 million acres are in cities, towns, railroad, and highway rights-of-way; and 59 million acres are barren or inaccessible. In addition, about 8.4 million acres of grazable land are at present closed to grazing in order to safeguard water supplies or for other reasons.

A CENTURY'S TOLL IN "FREE USE" OF THE RANGE

The figures given in table 5 indicated radical changes in area and ownership throughout the range area, but even more sweeping than these are the changes that have occurred in the forage resource itself,

[10] Several million acres of pasture in the dense forest type are not included in this 68 million acres. The total area of these pastures is so small that a separate type classification could not be established and they are included therefore in other range types.

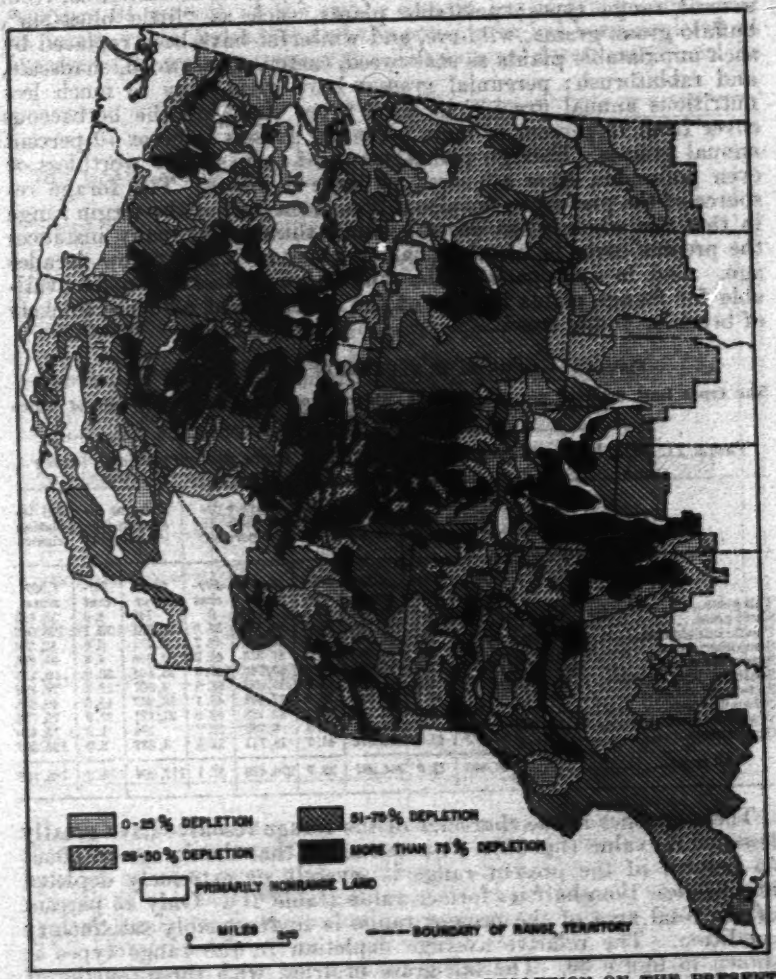


FIGURE 38.—DEGREE AND EXTENT OF FORAGE DEPLETION ON THE PRESENT RANGE.

Severe depletion (51–75 percent) and extreme depletion (76–100 percent) predominate throughout the West, save in the resilient tall-grass, short-grass, and Pacific bunchgrass types. (The white areas of primarily nonrange land comprise chiefly agricultural land, desert, and dense forest.)

as the foregoing type descriptions have made clear. These have involved striking adjustments in the composition of the vegetation cover. Valuable forage plants, such as bluebunch wheatgrass, giant wild-rye, and ricegrass have entirely disappeared, or almost so, from several range types; palatable plants, such as "little bluestem", buffalo grass, grama, wild-rye, and winterfat have been replaced by such unpalatable plants as snakeweed, cactus, greasewood, shadscale, and rabbitbrush; perennial grasses have given way to much less nutritious annual grasses, in some types changing the herbaceous cover from 75 percent or more perennial grasses to 60 or 70 percent annual grasses. Foreign plants, many of them nearly worthless or even poisonous, have appeared in large numbers. The forage resource of the present range also differs from that of the virgin range in that the whole plant cover is much thinner; in many instances the present cover is less than half as thick as it was a few decades ago. And, in some parts of the range, there is less soil space available for forage plants because of the development of dense thickets of brush or young trees.

FIGURE 39.—DEGREE OF DEPLETION IN FORAGE TYPES.

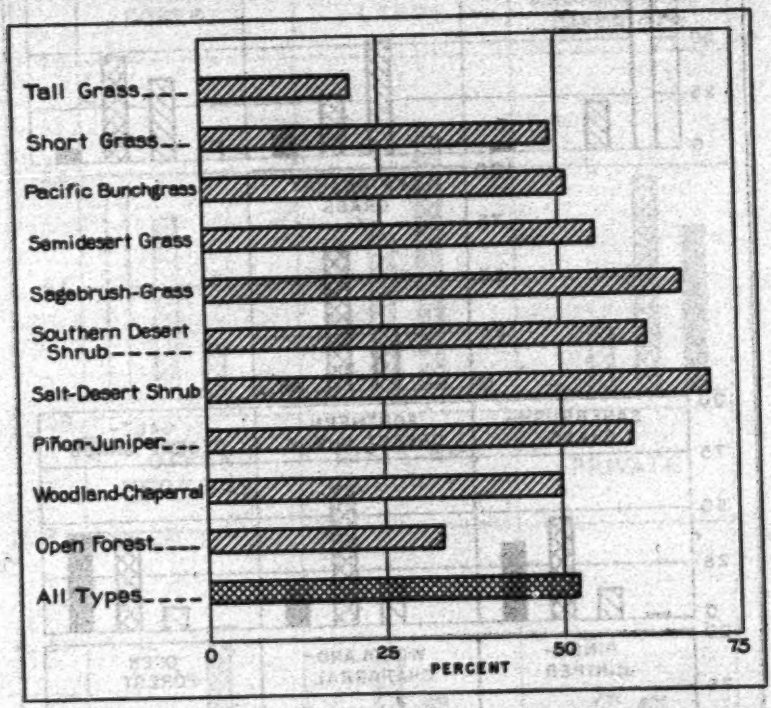
The types least depleted are the resilient tall-grass and the open-forest, half of which is in the national forests.

TABLE 21.—*Depletion of virgin range forage by types and depletion classes*

Type	Moderate depletion (0–25 percent)		Material depletion (26–50 percent)		Severe depletion (51–75 percent)		Extreme depletion (76–100 percent)		All depletion classes
	1,000 acres	*Percent*	*1,000 acres*	*Percent*	*1,000 acres*	*Percent*	*1,000 acres*	*Percent*	*1,000 acres*
Tall grass	13,880	72.4	4,175	22.6	0	0	749	4.0	18,513
Short grass	16,047	8.1	101,460	51.3	54,434	27.5	26,081	13.1	198,022
Pacific bunchgrass	3,484	6.2	15,882	26.7	20,731	48.7	2,737	6.4	42,534
Semidesert grass	2,317	2.6	26,209	29.3	57,363	64.3	3,336	4.8	89,274
Sagebrush-grass	1,619	1.9	13,466	14.0	45,948	47.8	25,565	26.8	96,528
Southern desert shrub	0	0	5,626	12.6	17,081	68.5	4,207	17.9	26,806
Salt-desert shrub	271	0.7	4,239	10.6	17,601	43.1	18,637	45.6	40,858
Pifion-juniper	5,978	7.9	16,441	21.7	32,198	42.5	21,121	27.9	75,738
Woodland-chaparral	162	1.2	6,287	47.3	6,735	50.2	174	1.3	13,409
Open forests	81,136	40.5	83,661	41.7	18,711	14.8	3,657	3.0	126,367
All types	94,825	13.0	344,997	32.7	270,470	37.1	117,904	16.2	728,196

These changes in the character of the forage resource have greatly lessened its value (fig. 38). It is estimated that the forage on about 55 percent of the present range is severely or extremely depleted and has less than half its former value (table 21). Only 15 percent of the total area of the present range is in reasonably satisfactory condition. The relative average depletion in the range types is shown in figure 39. The tall-grass prairies, with three-fourths of their total acreage having but moderate depletion, is in the best condition of any range type (fig. 40). The open-forest type of which 40 percent is only moderately depleted, and 18 percent severely or extremely depleted, is second best. The salt-desert-shrub type apparently is in the worst condition, since on nearly nine-tenths of its total area forage values have fallen 50 to 100 percent. The southern desert shrub, the sagebrush-grass, the semidesert grass, and the pifion-juniper types are now worth for forage scarcely a third of what they were a few decades ago.

The primary cause of forage depletion is poor management. For example, it is well known that the unreserved public domain has been treated as "free range", open to any number of livestock and subject to no regulations designed to maintain its productivity. As a consequence 84 percent of the public domain has lost more than half its forage value (table 22) and the entire area has been depleted an average of 67 percent (table 23). The national-forest ranges, on the



other hand, though in poor condition when put under regulation and though used continuously by large numbers of livestock have been handled so as to perpetuate and build up the forage resource. As a result of this better management, only 14 percent of these Federal grazing lands are in the severely or extremely depleted classes (fig. 41). Unfortunately, these demonstrated improvements in national-forest ranges can have but a minor influence in halting depletion on the western range as a whole, for the national-forest ranges constitute only 12 percent of the total grazable area in the West.

With destruction of the plant cover has come soil deterioration. As emphasized in another part of this report, sheet and gully erosion

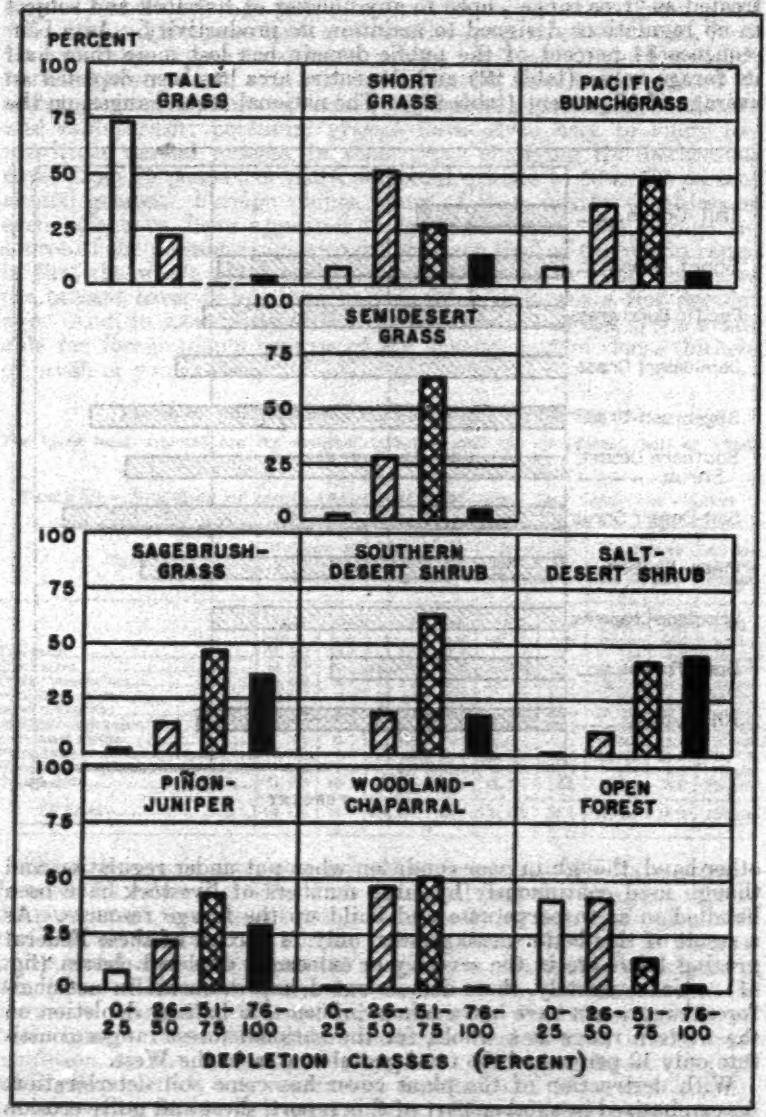


FIGURE 40.—DEGREES OF DEPLETION IN EACH TYPE.

Losses in forage values range from the very favorable condition in the tall-grass to the desperate situation in the shrub types.

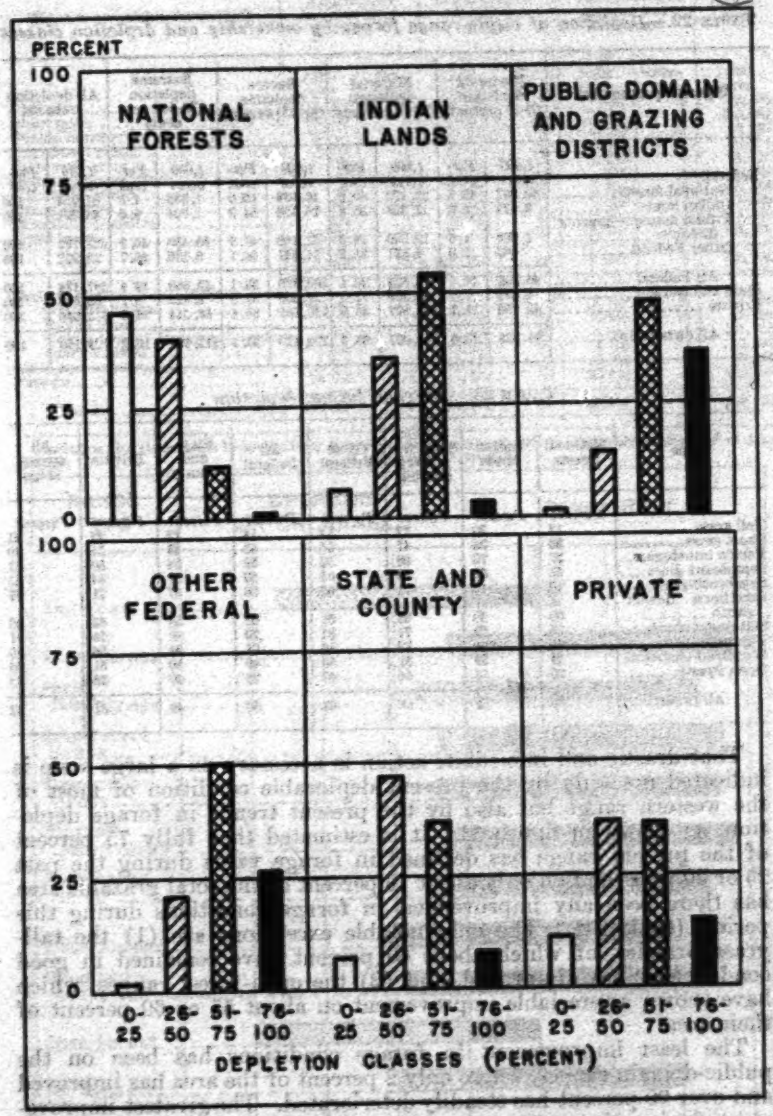


FIGURE 41.—DEPLETION IN THE DIFFERENT OWNERSHIP CLASSES

The advantages of grazing management are indicated by the small percentages of severe or extreme depletion on the national-forest ranges in contrast with other ownerships.

are appearing on many western ranges, washing away the fertile topsoil and preventing reestablishment of the plant cover.

TABLE 22.—*Depletion of virgin-range forage by ownership and depletion classes*

Ownership or control	Moderate depletion (0-25 percent)		Material depletion (26-50 percent)		Severe depletion (51-75 percent)		Extreme depletion (76-100 percent)		All depletion classes	
	1,000 acres	*Percent*	*1,000 acres*	*Percent*	*1,000 acres*	*Percent*	*1,000 acres*	*Percent*	*1,000 acres*	*Percent*
Federal:										
National forests	40,397	48.5	25,172	49.0	10,552	12.0	1,322	1.5	87,924	100
Indian lands	8,171	6.0	17,228	25.8	28,128	44.0	1,704	2.6	65,201	100
Public domain—grazing districts	1,988	1.5	18,229	14.3	61,166	47.9	44,489	34.3	127,792	100
Other Federal	489	2.0	4,871	21.2	11,537	50.1	6,126	26.7	23,007	100
All Federal	46,789	16.1	75,001	26.4	109,376	38.1	55,660	19.4	287,126	100
State and county	6,976	7.1	36,190	47.2	34,269	37.9	6,723	6.7	82,818	100
Private	43,780	11.7	166,297	36.9	126,825	36.4	36,814	13.0	373,646	100
All ownerships	94,525	13.0	264,987	33.7	270,470	37.1	117,999	16.2	728,189	100

TABLE 23.—*Average forage depletion*

Type	National forests	Indian lands	Public domain—grazing districts	Other Federal	All Federal	State and county	Private	All ownerships
	Percent	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*
Tall grass	13	31	12	12	14	12	22	21
Short grass	38	38	47	55	43	43	51	49
Pacific bunchgrass	37	70	68	89	55	54	83	61
Semidesert grass	33	63	89	63	60	61	54	55
Sagebrush-grass	40	48	71	59	66	67	71	67
Southern desert shrub	89	63	63	86	63	85	69	83
Salt-desert shrub	36	83	71	81	70	89	76	71
Pinon-juniper	61	61	72	76	63	64	58	69
Woodland-chaparral	44	39	51	59	49	59	51	50
Open forests	26	26	58	47	28	49	36	33
All types	39	51	67	68	52	49	51	52

That drastic and immediate action is necessary on a large scale is indicated not only by the present deplorable condition of most of the western range but also by the present trends in forage depletion, as shown in figure 42. It is estimated that fully 75 percent of the present range has declined in forage value during the past 25 or 30 years and on only about 16 percent of the total grazable area has there been any improvement in forage conditions during this period (table 24). The only notable exceptions are (1) the tall-grass prairies, of which about 60 percent have remained in good condition or have improved, and (2) the open-forest ranges, which have shown appreciable improvement on about 55 or 60 percent of their area.

The least improvement in forage conditions has been on the public-domain ranges, where only 2 percent of the area has improved and over 90 percent has steadily deteriorated. The greatest improvement during the past quarter century has been on national-forest ranges, of which about 77 percent are believed to have improved and forage depletion has at least been stopped on approximately 18 percent of the total area in these ranges.

TABLE 24.—*Trends in range forage depletion for approximate period 1905–35*

Type or ownership (or control)	Appreciable improvement in forage [1]		Appreciable decline in forage		Forage conditions more or less unchanged		Total area
	1,000 acres	Percent	1,000 acres	Percent	1,000 acres	Percent	1,000 acres
Tall grass	11,709	91	4,344	34	838	7	13,315
Short grass	16,446	8	188,888	92	2,883	1	208,218
Pacific bunchgrass	2,477	6	36,297	89	4,209	11	42,984
Semidesert grass	3,698	3	89,717	91	6,276	7	99,691
Sagebrush grass	2,488	4	57,105	90	4,098	6	63,691
Southern desert shrub	44	(2)	35,911	96	1,511	4	37,466
Salt-desert shrub	370	1	35,497	96	1,111	3	36,978
Pinon-juniper	14,089	20	54,888	78	1,318	2	70,295
Woodland-chaparral	888	6	13,221	78	2,922	17	16,981
Open forests	72,967	46	81,670	52	31,710	17	186,347
Total	112,498	16	588,670	76	87,118	8	726,166
Federal ownership and control:							
National forests	67,980	77	8,965	8	15,799	15	97,954
Indian lands	4,276	10	36,150	75	7,885	15	48,311
Public domain—grazing districts	2,967	2	112,146	93	6,047	5	127,762
Other Federal	1,223	7	15,086	91	2,735	12	22,997
State and county	4,270	7	57,473	88	3,884	5	65,516
Private	32,944	10	315,849	88	30,369	8	379,948
Total	113,498	16	582,670	76	87,118	8	726,166

[1] Includes also those areas in satisfactory condition at beginning of period which are unchanged in condition.
[2] Less than 0.5 percent.

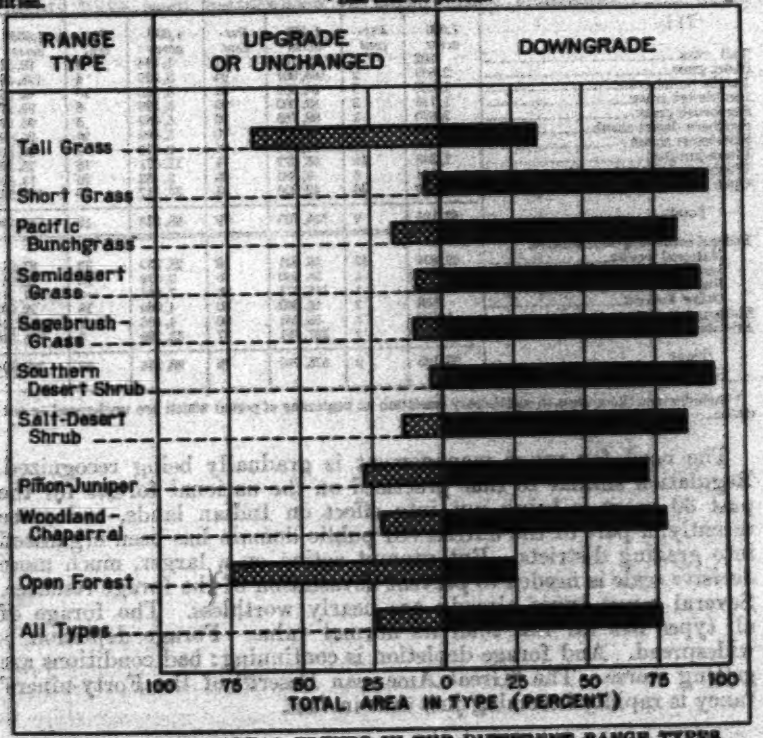


FIGURE 42.—THIRTY-YEAR TRENDS IN THE DIFFERENT RANGE TYPES.
Over a large portion of the vigorous tall-grass type, and also in the open forest, half of which is under national-forest management, forage values are improving or at least stationary. Downward trends in the greater part of the other types reflect mainly the results of unrestrained use.

More recently (table 25), these proportions have changed for the national forests. It is estimated that only about 50 percent of the national-forest ranges are continuing to improve, although further forage depletion has been stopped on about 32 percent of the total area of national-forest ranges. The reason for this recent change can be traced directly to the increase in number of livestock permitted on the national forests during the World War, aggravated by the recent exceptionally dry years. For various reasons, which will be explained in a later chapter, it has not been possible to reduce the number of livestock using these ranges to limits which officials know to be necessary to preserve the forage. The recent droughts, coming at a time when the range was overstocked even for normal years, caused a still further decline in forage values. No appreciable changes in forage depletion trends have been noted for other ownerships, since these (as shown in tables 24 and 25) already were 85 percent or more on the downgrade.

TABLE 25.—*Trends in range forage depletion for approximate period 1930–35*

Type or ownership (or control)	Appreciable improvement in forage[1]		Appreciable decline in forage		Forage conditions more or less unchanged		Total area
	1,000 acres	Percent	1,000 acres	Percent	1,000 acres	Percent	1,000 acres
Tall grass	202	1	15,707	97	1,644	8	17,553
Short grass	2,860	2	100,977	94	5,235	4	109,072
Pacific bunchgrass	1,089	3	34,600	91	2,950	16	42,634
Semidesert grass	1,746	2	82,033	92	5,295	6	89,274
Sagebrush-grass	2,670	3	86,760	93	4,080	5	93,510
Southern desert shrub	120	1	21,287	79	5,400	20	26,806
Salt-desert shrub	490	1	39,599	94	2,073	5	42,162
Pinon-juniper	7,286	10	55,573	74	12,471	16	75,728
Woodland-chaparral	944	6	9,080	68	3,402	26	13,426
Open forests	6,880	36	42,900	24	87,317	20	136,997
Total	28,195	9	576,706	79	88,286	12	728,196
Federal ownership and control:							
National forests	42,884	49	16,821	19	28,229	32	87,934
Indian lands	1,660	4	35,700	78	8,676	18	46,231
Public domain—grazing districts	1,849	1	118,873	82	7,844	6	127,762
Other Federal	880	2	18,880	83	4,080	13	23,497
State and county	1,082	2	58,041	93	4,292	7	62,515
Private	14,258	4	227,191	67	32,760	9	273,945
Total	62,196	9	576,706	79	88,285	12	728,196

[1] Includes also those areas in satisfactory condition at beginning of period which are unchanged in condition.

The need for range management is gradually being recognized. Regulation similar to that practiced on the national forests for the past 30 years is being put into effect on Indian lands, and more recently, a part of the unreserved public domain has been organized into grazing districts. But prompt action on a larger, much more decisive scale is needed to prevent devastation of the forage resource. Several range types already are nearly worthless. The forage of all types has far less than its normal value. Forage depletion is widespread. And forage depletion is continuing: bad conditions are getting worse. The "Great American Desert" of the Forty-niners' fancy is rapidly becoming just that in fact.

IV. HOW AND WHY

Information such as that already given on the range in its virgin and present condition is necessary as a basis for the constructive program, which is the fundamental purpose of this report. Equally necessary is an understanding of the how and why of what has happened. The story which follows in this chapter is mostly the how and why of depletion, the historical events, the influence of a climate not too favorable, the philosophy of range-resource management and how it has been reflected in the everyday use of the range, the philosophy of land ownership and how it has been reflected in land legislation, interpretation, and administration, the various financial forces—a complex interrelated group of causes and forces which have blinded both range users and the public to trends and consequences. In smaller degree the story is also of how and why some ranges have been practically restored and some fragments have been maintained in satisfactory condition.

HISTORY OF RANGE USE

By George Stewart, Senior Forest Ecologist, Intermountain Forest and Range Experiment Station

The Great Boom in Range Cattle, 1880–85

The first era of intensive use of western range by livestock coincided with the great boom in range cattle, which was on the upswing in 1880. By 1881 the price recovery from the 1873 depression generated in the grazing industry a tide of expansion which became a veritable flood in 1883. That year, in Wyoming alone, 20 mammoth cattle companies were organized with a total capitalization of more than $12,000,000 (*98*). Of these, the Union Cattle Co. was incorporated for $2,000,000; and the North American Cattle Co. and the Searight Cattle Co. for $1,000,000 each. Six others each floated stock of a half million dollars or more. Wyoming, however, was merely a representative area—the same thing was happening, or had just happened, up and down the Great Plains from Montana to Texas and across the Southwest to California. Even Colorado, Utah, Nevada, and Idaho felt the surge of this tide. In a few short years practically all ranges were under use and in many cases depletion had commenced on a scale in keeping with the size of the herds.

Outfits owning 5,000 to 100,000 cattle were common on the Plains and in the Southwest, and properties of small owners were often consolidated by purchase or by incorporation. The world-famous Santa Gertrudis Ranch of 500,000 acres near Brownsville, Tex., was built up by purchased additions to the original Spanish grant of 12 secios of 4,428 acres each (*118*). The Swan Land & Cattle Co. was started by combining three ranch properties, totaling about 30,000 acres and 100,000 cattle, with a half-million-acre range extending irregularly from Ogallala, Nebr., westward to Fort Steele, Wyo., and from the Union Pacific Railroad northward to the Platte River (*98*). The XIT outfit in the Texas Panhandle ran about 150,000 head on 3,000,000 acres of land—25 miles east and west by 200 miles north and south. Hundreds of other ranches running somewhat fewer cattle, chiefly on public land, had occupied most of the range by 1883 and all of it in the Plains Region by 1885 (*19*). The cattle numbers by States, shown in table 26 for 1870, 1880, and 1886, indicate how rapidly the range forage was appropriated.

Table 26.—*Cattle numbers[1] in the 17 western range States, for 1870, 1880, and 1886*

[000 omitted]

State	1870	1880	1886	State	1870	1880	1886
North Dakota	2	70	139	Montana	117	690	1,000
South Dakota	40	126	430	Idaho	50	126	220
Nebraska	126	1,000	1,712	Utah	125	130	215
Kansas	371	1,247	2,434	Nevada	73	200	225
Oklahoma	130	552	800	California	1,001	914	1,325
Texas	4,000	4,902	6,807	Oregon	276	621	800
New Mexico	160	845	1,065	Washington	100	307	500
Arizona	30	142	902				
Colorado	271	949	1,326	Total	7,007	12,921	21,000
Wyoming	71	520	857				

[1] Tentative revisions of the Bureau of Agricultural Economics.

Because such immense numbers could not be run on the range without cattle of different ownerships intermingling, the managers mutually agreed to honor each other's "range rights." These "rights", for the most part, had no legal status but were respected for many years; and when smaller operators and settlers began to push in, the large outfits often used extra-legal pressure to preserve the monopoly they had enjoyed under these illicit "range rights." Original outfits with only a few hundred cattle were accepted as part of the country, but after 1883 whenever newcomers tried to enter what the established residents regarded as fully occupied range they were practically frozen out by the resident stockmen, who refused to cooperate at round-ups and other group efforts (*68*).

Grasses of the Boom

The buffalo, deer, elk, mountain sheep, antelope, and other forms of wildlife, large and small, that were the first users of the range had little or no discernible effect upon it in terms of depletion. Heavy use by vast roaming or migrating herds of buffalo was common, and around strategic watering places, salt licks, and on favorite breeding grounds range forage would be so fully grazed that little or no feed remained. Yet in every instance seasonal migrations of the herds permitted recovery of the vegetation between grazing periods.

In all other instances of temporary exhaustion of the range resource, such as overuse by huge colonies of prairie dogs (*88*), or utter destruction of forage by locusts (*178*), or crickets (*11*), sufficient periods of recuperation occurred to maintain the productive power of the original range. No evidence remains to us from those times of such persistent overuse as came when the white man began to pasture his cattle year after year on the same range, without affording any opportunity for restoring plant vigor.

The Spanish brought to their settlements in Cuba, Florida, and Mexico ancestors of the livestock destined to use much of these ranges. Stock have grazed intermittently on the southern plains since 1540 when Coronado there sought the Seven Cities of Cibola, taking with him 1,000 horses, 500 cattle, and 5,000 sheep. The period of continuous grazing began about 1700. At this time, Father Kino, a Jesuit missionary, was very active in promoting livestock raising among the missions in southern Arizona (*70*).

Missions established in Texas, New Mexico, and Arizona between 1670 and 1690, became livestock centers soon after 1700. It seems likely that from 40,000 to 50,000 sheep and 10,000 to 20,000 cattle were brought to Texas during the mission period. The more settled Indians of New Mexico and Arizona fostered sheep and ponies. The latter proved well adapted to range grazing, became prized Indian property, and multiplied so rapidly and were so widely distributed that by 1805 Lewis and Clark found 700 Spanish ponies at one small village of Shoshone Indians in northern Idaho (*57*).

California missions, established between 1769 and 1800, so prospered under the guidance of the padres that in 1834, when the 21 missions were taken from the church, they had 423,000 cattle, 61,000 horses, and 321,500 sheep, goats, and swine (*58*). Range use must

have been of major consequence at San Luis Rey where 80,000 cattle, 10,000 horses, and 100,000 sheep, goats, and swine grazed.

Texas proved to be especially well suited for cattle. In 1821 the Mexican Government contracted with Moses Austin to bring settlers into Texas, and many came, enticed by liberal tracts of land; and the success of Austin's colonization scheme then brought a host of requests for similar grants (*100*). In 1830 further American immigration was prohibited, but already about 20,000 Americans were there whose attention to cattle growing, together with the mild climate, so favored cattle that the stock multiplied to 100,000 in 1830; to 330,000 in 1850; and to 3,535,000 in 1860 (*180*).

With the Civil War came the first large cattle shipments from Texas to the Confederate Army. Despite the restraining influence of the northern blockade, the consequent stagnation, and the fall of prices to $3 or $4 a head, ideal range conditions favored still further increase, and made Texas a hive of cattle ready to swarm forth at the first opportunity. This came after the war, when currency inflation and rising prices in northern manufacturing centers, together with a decrease of 7 percent in total cattle in the United States, brought market offerings of $40 to $60 for beef steers (*98*).

The railroads in Missouri, central Kansas, and Nebraska offered outlets for these crowded Texas herds. In 1866, real drives to Sedalia and Abilene began, and in 1867 when the demand and prices were up, more than 1,000 cars left Abilene. Actual demands reached such a volume in 1871 that 600,000 cattle were driven northward to the railroad in that year. The heavy range use in western Kansas and Nebraska that began with these drives never ceased until the grass was plowed under, although dropping prices decreased the profits and hence the number of drives. By 1885 a total of more than 5 million cattle had been driven northward from Texas (*98*).

In a few years, however, fences began to be built, settlement was well under way, and railroads were extended into the arid region. Advance of main and branch railroads into the range country brought the market to nearby railheads. Drives were no longer necessary and, as the use of barbed wire for fencing cattle away from farms and towns became general, they were discontinued entirely in 1885. Intense range use was encouraged by the railroads, and by 1890 had been extended with their help to every nook and corner of the region.

Meanwhile the Mormons filled the Utah ranges with foundation stock which they themselves drove across the Plains, and with lean cattle and horses obtained by trading with other emigrants. By about 1880 the ranges in northern and central Utah were occupied with 160,000 Shorthorns, Devons, and Herefords (*11*).

With the discovery of gold in the Rocky Mountains during the sixties, cattle were taken from Utah and California into Colorado, Montana, Idaho, and Nevada. The strong markets of the late seventies and early eighties carried grazing onto most of the accessible ranges in the mountain region. Here, however, development of the country was slower and more substantial, since it came in connection with homes and farms. Wild hay and irrigated alfalfa produced abundantly and from the first lent stability to range use on a community basis.

The tremendous growth in range cattle, however, carried with it a weakness that in the end proved fatal. It was based on a husbandry transplanted from Mexico, which brought to English-speaking people for the first time in history the practice of rearing cattle in great droves without fences, corrals, or feed. The lariat, the type of saddle, chaps, and the sombrero came along with the manner of conducting the business. The very newness of it all as well as the immensity of the outfits left the Americans without guide or standard by which to gage either the security of the cattle as they roamed at large or the ability of the forages to stand up under continual intense utilization. It is little wonder, therefore, that cattle instead of grass came to be regarded as the raw resource and that the neglected forages began to give way before the heavy and unmanaged use to which they were subjected.

This almost explosive expansion of cattle grazing was based on a great natural resource which the stockmen obtained with little cost. Grass was the magnet and living bonanza that irresistibly drew cattle and cattlemen to this range El Dorado.

Like the El Dorados of precious metals, the discovery of the grass bonanza fired the imagination of cowboys, lawyers, farmers, merchants, laborers, and bankers, who rushed in to seek their fortunes, the poor by personal effort and the rich by investment. Both eastern and Old World capital, the latter largely from England and Scotland, fevered through the expectation of profit of 25, 33, or 40 percent. A large promotion literature flourished, including such widely circulated books as Brisbin's Beef Bonanza. After presenting several actual cases, Brisbin showed on paper how $35,000 would in 6 years pay all expenses and leave a fortune of $51,278. Estimated Fortunes and Millions in Beef are significant chapter headings (*21*).

Since a boom was in progress, the stories were believed. Swan, of the Swan Land & Cattle Co., promoted in Scotland the corporation with the capitalization of $3,000,000 already mentioned, and later increased this to $3,750,000—and paid a few dividends from the capital (*23*). Some companies really did make money for a while, but lax methods accompanied this "easy" money. Cattle were bought on "book" count, and newly purchased cattle were seldom counted. Purchase prices soared, because purchasers bid against each other, and because of the buying of breeding stock whose offspring started other breeding herds, most of which never went to a consumer market but accumulated as capital inventory until the collapse of 1886.

The Collapse of the Boom

The expectation of fortunes to be made in a few years led to gambling in futures and caused overexpansion both in investments and in range use. In this process the accumulated forage of several years was mined, overuse taking not only the current growth but sapping as well the vigor of the forage plants. The better stockman recognized the danger (*98, 133*), but warnings in a minor key during a boom got no hearing, and exploitation raced on.

This constant drain, without allowing any chance for recuperation, caused the forage "mine" to peter out. In 1898 Bentley (*16*) reported that some stockmen considered that in parts of Texas "the injury has gone almost past the point where redemption is pos-

sible." Ranges that should have carried a cow on every 40 acres had one on every 10 acres.

While this dangerous process of depleting the ranges by overuse and by too early and too continuous grazing was going on, scarcely anybody was making provision for supplementary feeding or for setting aside winter ranges. Neglect of cattle diseases, too, made the risks still higher. All business was conducted on the basis of open winters, notwithstanding the fact that Shorthorns brought from the farms of the East and Texas stock arriving in late season did not go through the first winter safely. Investors, believing implicitly in the security of their capital, did not realize they were "betting against God Almighty and a sub-Arctic winter" (*98*).

Whole fortunes, either owned or borrowed, and speculative loans of millions each were all staked on cattle. With no source of income save cattle, the stakes were high and the risks breath-taking; but since it was a boom, men were irrational. The waste, too, was exhausting; cowboys, fully employed only a few weeks at roundup and branding, lived during the winters mostly at the expense of the ranch owners.

And just at this point nature spun a "double blank" and collected the stake. The winter of 1885–86 was severe from Kansas southward to Texas and New Mexico. Osgood says 85 percent of the cattle were killed in some areas. In the north the summer of 1886 was hot and dry, grass was short, and cattle were forced on the market at reduced prices. In November an Arctic winter set in; snow was deep; blizzard followed blizzard; the chinook was followed at once with snow. Young stock fresh from the East and from Texas died in great droves, with a mortality of 40 to 60 percent (*40*). Ranges were so closely cropped that cattle losses would have been heavy in a mild winter, but with severe cold and deep snow, the lack of feed was economically fatal to many stockmen, especially to the speculatively financed corporations. The somewhat inaccurately recorded numbers of assessed cattle in Montana decreased from 663,716 in 1886 to 471,171 in 1887; in Wyoming from nearly 900,000 in 1886 to just over 750,000 in 1887. Financial confidence, which started to wane in 1885, was almost completely lost, and the winter of 1886–87 gave a body blow to the beef bonanza. When the depression caused loans to be called, credit liquidation brought forced sales and bankruptcy.

Starvation of cattle followed severe droughts in the Southwest in 1886 (*75*), in Colorado in 1888–90, in the Plains and Southwest in 1893–94; in the Coast States in 1898–99, and from Montana to Arizona and New Mexico in 1901–4.

Recovery—Striving for Security on the Cattle Range

So weak had the boom structure been and so severe the shock of its fall that only a wreck of the range-cattle industry remained. Range use had been so concentrated and relentless that the best coulees were hopelessly trampled, and the back slopes weakened in productive power. Herds were broken and scattered; confidence was wiped out; and forced sales for liquidation of debts pressed down the already broken prices. Cattle which were worth $2.35

per hundredweight in 1882 at Chicago brought $1 in 1887 (*19*). Naturally, the outfits supported by foreign capital, without the personal care of a vitally interested owner, suffered most; the "cattle barons and bovine kings faded out of public interest." On the other hand, those to whom cattle raising had been more than a wild adventure for big stakes fared best.

While the range was used recklessly by most ranchers, the necessity for providing a dependable forage supply was felt, even before the ruinous winter of 1886–87, by a few stockmen who had purchased land in an effort to prevent summer use of range suitable for winter grazing (*98*). Others, realizing that controlled ranges had advantages, were willing to relinquish their "rights" and persuaded the national convention of Cattle Growers to recommend Federal leases on the public range (*53*). Before the boom, in 1881, stockmen of both Montana and Wyoming fought against enacting the law suggested by Powell for enlarged "arid homesteads", and urged that all proposals to lease land be rejected; but after the boom they felt differently about the situation (*107, 176*).

No action on this recommendation was taken by the Federal Government and the cattlemen then attempted to acquire ownership of as much land as possible. Cowboys were hired to enter land and for a small sum turn it over to their employer. Lands along streams where cattle could water and where wild hay could be grown were acquired first, and later more and more upland range (*98*).

Windmills, which came to be widely used for pumping water to range at a distance from streams, added another expense, but it was evident that adequate forage must be assured. Cattle yards and loading and sorting chutes were erected. Also ownership of land was accompanied by higher grades of livestock; purebred bulls (Shorthorns at first, but after 1887 Herefords, which had proved more hardy and also earlier in maturing) were introduced (*118*). This use of better stock was in turn accompanied by the use of shelters; death by starvation or by exposure of a Texas cow worth a few dollars had not been serious, but that of a $200 or a $300 bull was avoided by providing shelter and feed, and thus the combination of hard winter and market collapse changed the range-cattle industry from an adventure into a business.

From this point on, the history of the range is largely the story of the struggle between the big owner and the little owner, with the cattle "rustler" as an unrecognized but inevitable ally of the small owner. The Wyoming Stock Growers' Association was strong enough to blacklist cow hands who had herds of their own, and even certain of its own members, but a rustler on trial often had an accomplice or several sympathizers on the jury. Since convictions were impossible in these cases and the association was strong, a lariat on a cottonwood brought swift justice. Although the association unduly prolonged its "vigilante" efforts after legal justice was provided, it cannot be denied that it did much to put down cattle rustling, and kindred practices.

The land homesteaded by cowboys to add to the big ranch was in many cases so located along the streams as to prevent another stockman's cattle from drinking. Larger outfits sometimes in this way covered all the water courses in the vicinity and by entering a few

quarter sections they obtained control of many thousands, sometimes hundreds of thousands, of acres of Federal land (*180*). Agreements among the big stockmen not to cooperate with newcomers in round-ups and other group activities, in a concerted effort to squeeze them out, aroused resentment.

Affairs gradually assumed a state of social warfare, culminating in 1892 in the "Johnson County war", when the association undertook to punish the residents of Buffalo, Wyo., for "harboring and abetting suspected rustlers." Several men were killed; the Army Reserves were called out; and arrests of well-known cattlemen followed. Although the matter was hushed up, the big stockman's range monopoly was effectively broken; law and justice were hereafter applied with some show of impartiality to operators of small and large outfits (*98*).

After this, contention decreased and progress in peaceful settlement made headway. The industry was not, however, to ride an even keel, for cattle values which had reached another crest in 1898 tumbled so rapidly that in 1905 they were only a little over half the 1898 figure. After this there was a slow recovery until the European war again brought high meat demands and soaring prices.

Increase in Sheep Accentuated Bitter Struggle for Range

Just when security in the ownership of cattle was becoming established and the West was being taught the necessity of welding land to livestock to insure dependable forage supplies and range use, a tremendous and rapid increase in sheep again stirred up the struggle for range.

Sheep numbers quickly rose from a comparatively small figure to veritable hordes. This increase came at different times in different States, but maximum numbers were reached in most States between 1880 and 1910. In California the gold boom brought an increase from about 1 million in 1859 to 4.1 million sheep in 1870 and 6.9 million in 1880. New Mexico sheep reached their peak number in 1882 with 5.2 million and Texas an early peak in 1884 with 5.7 million. From a few hundred thousand in the early eighties the sheep in Utah increased to nearly 2.9 million in 1901, in Idaho to about 2.6 million in 1903, in Montana to 5.7 million in 1903, and in Wyoming to 6 million in 1900.

Vast numbers of sheep appearing almost without warning on fully used cattle ranges not only aroused a deep resentment but had a dire effect in causing even further exhaustion of the range forage. Compact herds left the range plants shaved to the ground and the soil exposed to wind and water erosion (*185*). Also sheep were crowded right up to ranches and settlements, and since cattle fences did not keep out sheep, sometimes even hay fields were invaded. Even more destructive of range than the ordinary wool herds were the bands of wethers, which could outdistance ewe herds in the race for feed.

Cattlemen resorted to force in many localities, sometimes scattering bands of sheep, sometimes driving them over precipices, and in some places setting up dead lines that sheepmen were warned not to cross. But herders and owners of sheep were robust frontiersmen, and sometimes when a particularly aggressive herder was threatened

firearms were used, and the cattle-sheep feuds waxed hot. Throughout the West there were many such feuds, some of which resulted in as many as 30 deaths (*12*), and only after both cattlemen and sheepmen were convinced by the community that violence brought retribution to both contestants did the feuds cease.

The outcome of such a relentless contest for range was complete utilization of forage; the only way to prevent another outfit from obtaining a given range was to strip it utterly naked. To make conditions still worse, this plant spoilage struck at the very foundation of the range resource by furthering the loss of the most productive soil—the friable, humus-bearing surface layer.

After 15 or 20 years of such exhausting range use the better forage plants succumbed on great blocks of range; in other areas their vigor was so reduced that growth was dwarfed and belated until there was little top growth and no seed crop (*115*).

Depleted and restricted ranges, with the resulting increased expenses, skimmed off most of the profit (*153*). Wool prices dropped during the early nineties and again just after 1910 (*56*). Sheep, therefore, declined during the nineties in California and Texas, during 1901–5 in Utah, and during 1910–20 in some of the other States, but in 1920–29 there was a rather large increase in several of the Mountain States.

The decreased value of wool and the rising demand for lambs brought about a marked reduction in wethers and consequently eliminated the worst form of range use. After 1915 herds consisted largely of ewe-breeding stock; when 3 or 4 months old all the wether lambs and half the ewe lambs were sold (*153*).

The market-lamb industry, with its heavy investment in good breeding herds, and the range-use difficulties forced the sheepmen to seek sure feed. Shortly after 1900 national-forest permits began to assist greatly; some private land was leased and some was purchased (*153*). The sheep industry then took on two distinct aspects: (1) Market lambs as a major product, supported by heavy investments in land and facilities; and (2) wool and range lambs combined, with a small investment. Though use of range on the national forests hastened the combining of the land with sheep, this was a phase of the evolution of the industry and would have come about in any case.

Two results thus arose from the use of owned land: (1) Transient, nomadic outfits decreased in number; (2) range use was in part limited to the grazing of a definite area, supplemented by feed from cultivated land.

In Texas, in the Southwestern States, and in Oregon the problems of sheep grazing were further complicated by the increase in Angora goats. The first importation came from Turkey in 1849, and another in 1860 (*109*). Increase was at first slow, but about 1910 it took on real proportions. Texas had 242,000 goats in 1899, 1.7 million in 1909, 2.9 million in 1922, and more than 3.9 million in 1930 (*1*).

On Edwards Plateau in Texas, the area of greatest concentration, cattle and sheep were grazed in fenced range pastures before goats came in. At first it was thought that goats might benefit a range by holding brush in check, but in time the better forages decreased and the poisonous bitter rubberweed increased.

Goats are run in smaller numbers in New Mexico, Arizona, California, Utah, and Oregon, where they graze on rough, brushy areas;

but when herded closely, often by alien owners, they have in many cases stripped the range of nearly all vegetation. Such forage depletion does not occur, however, when the goats are handled in open herds on properly stocked ranges.

The increase in sheep and goats was in part compensated for by a decrease in horses. Indians and settlers had numerous ponies, which, along with the bands of wild ponies, constituted a major range use until about 1908, when stockmen and settlers began rounding them up and shipping them out (*60*). Shooting wild ponies also was a regular practice on some ranges. The reduction of farm horses by motorization has decreased range use by horses still more. However, the gain by the decrease of horses was not nearly equal to the increased demand by sheep and goats.

Settlement Intensifies Tendency to Range Depletion

Settlement, which sometimes preceded and sometimes followed the influx of sheep into a locality, markedly intensified the severity of range use. Encouraged by land booms, by high prices for cereals, by railroads, and by a few favorable seasons, crop-growing was pushed far beyond the line safe for tillage (*94*). Believing that cultivation brought increased rainfall and encouraged by a few years with more than average rain, the settlers turned good short-grass range wrong side up and ruined it for grazing.

Crop growing became successful on part of this land, but the venture often failed in the long run unless irrigation was practiced. A few inches below the surface of most soils was a hardpan largely impervious to plant roots, and the soil above was not deep enough to hold much moisture (*178*). Nevertheless, these precarious lands were oversettled, only to be abandoned in a few years. In western Kansas there was a succession of such waves of settlement a generation apart.

The most productive range lands were ripped up for wheat or corn, thereby decreasing both the acreage and the acre-yield of forage. Between 1880 and 1890, 104 million acres were taken for crop growing, largely on the Plains. Settlement served both as means of reducing range and also as a means of producing hay and cereals which tended to furnish a more stable feed supply. As the range area decreased, range use by resident stockmen was concentrated on the unplowed area with resulting overutilization, a condition accentuated by the settlers' farm stock.

In the mountain region settlement took place almost entirely on "spring-fall" range, already the least adequate of the three seasonal ranges. Livestock were crowded upward into the lower edge of summer range on the one hand and out to the winter ranges on the other (*133*). Use of the summer range at the wrong season did great injury by exposing the best forages to too early grazing, and the winter range, with only a sparse plant cover, suffered from being grazed in the fall and spring periods of recuperation.

Not all settlement influences, however, were harmful to the range. Irrigation to increase forage production is the natural complement of grazing in an arid region. Alfalfa growing began in the fifties in California, whence it spread eastward to Utah before 1860 and

from there to Colorado about 1185 and to Montana about 1890. By 1909 more than 6,000,000 tons of alfalfa hay were produced in the range States, much of which was used to supplement range forage. Only 1 to 2 percent of the land area was growing alfalfa, but the yields were 5 to 10 times as great as those from native forages. Moreover, alfalfa hay was unusually rich in proteins and minerals, and thus made an unexcelled feed supplement for grazing stock (*135*). Stubble fields and irrigated pastures made the handling of livestock more convenient and strengthened the animals by furnishing a variety and abundance of feed for a few days or weeks as the animals moved from one seasonal range to another. Stockmen could depend on a definite food reserve to tide their animals over emergency periods of food shortage such as are occasioned by severe winters or by prolonged drought.

The practice of feeding hay and grain to livestock increased rapidly in the Plains States after the severe winter of 1886–87, and in the Southwest after the drought of 1891–94. The total supplemental feeds, including irrigated pasturage, furnished to livestock increased in the range part of the Plains States from 5 percent of total forage eaten in 1890 to 17 percent in 1910; in the 11 far-western range States such feeds increased from 12 percent in 1890 to 40 percent in 1910. In 1935 these feeds constituted 29 percent of the total forage in the Plains States and 43 percent in the 11 Western States. Such rapid increase in the practice of feeding grew out of heavy winter and drought losses which resulted in part from the depleted ranges and in part from the absence of any provision for suitable reserve range for use in winter or during dry periods. Breeding and other animal husbandry practices brought great incentives for feeding the more valuable animals. The small area of many ranches also tended to favor feeding as opposed to grazing.

As a result of the limited areas of land that could be taken by homesteading, varying from 160 to 640 acres, most settlers who became stockmen obtained holdings much too small and frequently too nearly submarginal for family support. The more fortunate ones were able to purchase more land, but the great majority struggled along with one homestead and whatever public range they could salvage, which early became very limited and consequently seriously overgrazed. This vast number of too-small holdings was concentrated near larger irrigation projects, where the high cost of irrigation water and of preparing the land for irrigation frequently limited the size of such farms to 20 to 80 acres, too small an acreage to permit much farm pasturage.

One of the worst phases of the settlement of the better range land by small ranchers and farmers was the bitter struggle over land use which it engendered. Corporate livestock outfits sometimes obtained legitimate ownership control of streams and springs, but more often, as we have seen, they depended on intimidating the settler who came with just enough capital to make a humble beginning. Soon the settlers entered land along the streams inside illegal enclosures. The cropper fenced his grain field and garden, turned his animals out to graze, dug a canal, and put in a diversion dam. One day his cattle disappeared, his fences were cut, the canal broken, or the dam demolished. Suspecting the stockmen, he retaliated by killing or driving away cattle or by cutting the drift fence.

When sheep outfits crowded in upon the isolated settlers or upon a small irrigated community, the sheep seldom left much forage for domestic farm stock, making it necessary to feed teams and milk cows the entire year or else provide irrigated pasturage. This the settlers considered decidedly unfair (*94*). This three-cornered fight among cattlemen, settlers, and sheepmen was a complex pattern of bitter feelings, especially when a huge incorporated stock outfit was involved. Worst of all, it put a premium on forestalling another outfit, and stripping a neighborhood nearly bare of forage in order to keep out a competing user.

This competition led to increased operating expenses and to investment expenditures the purpose of which reached beyond forage management. Heavy investments in land, buildings, fences, water developments, and miscellaneous supplies were made to provide shelter, feed reserves, pasturage, and better grades of livestock. However, little or nothing was spent for management of ranges, a phase in urgent need of improvement.

The serious effects of poor range management were increased in many sections by fires, particularly in California, where forest and brush fires have played an important part in molding and shaping the vegetation. Historic evidence and the reconstructed story through fire-scarred tissue on century-old trees indicate that fires frequently swept forest and foothills alike. But the damage caused by these presettlement fires was less serious because nature in her own way slowly started anew the process of rehabilitation and building back to climax vegetation. Once civilized men entered into the picture, fires increased in number and restoration was indefinitely retarded. The miner, the early sheepman, and the careless traveler all contributed annually to the inevitable smoky skies and burned forests (*128, 145*). The net result was the extension of vast areas of chaparral, chamiso, and other brush areas of lowest forage values, replacing on the upper elevation coniferous forests and on the lower levels the more open parklike woodland and savanna types. In this process grass and herbs were replaced by undesirable woody shrubs, which in repeated fires of the timber type produced forage for a short period, followed in a few years by impenetrable thickets of manzanita and ceanothus. On areas where fires were used freely and where overgrazing followed, perennial grasses frequently were replaced by a host of "immigrant" annuals from the Mediterranean region of much lower forage value.

Establishment of Public-Land Control a Stabilizing Factor

The creation of the national forests, on which are grazed 12 percent of all the cattle and 23 percent of all the sheep in the West, greatly stabilized range use and livestock production. An effort was made to administer grazing on the national forests for the benefit both of the permanent stockmen and of the adjacent agricultural communities. Having a definite range allotment with 3 to 5 months of dependable summer feed of high quality helped the stockmen to make the adjustments necessary to supply feed for the remainder of the year.

Prior to 1930 some organized attention was given to the principles of range management on northern Indian lands. In 1930 responsibility for the supervision of all grazing was delegated to the forestry branch of the Indian Service, and a distinct forward step was taken by inaugurating a plan of management similar to that developed on the national forests.

The Taylor Grazing Act of 1934 provided authority to administer 80 million acres, or about half the public domain, and made possible a step toward the management of the grazing on these lands.

Recently wildlife and game management have come to the front in the national forests as problems to be correlated with grazing. Recreation, both on national forests and on national parks, has also increased greatly in importance since automobiles came into general use. The parks, as reservoirs for wildlife, have become much better known than formerly. Under the previous near absence of control, game and other wildlife in the country as a whole decreased to small populations, whereas under the unplanned protection used in the West from about 1915 until recently game became so congested in some areas as to require serious attention. It is likely that use of the range by game will increase in many places, but under good management it need not conflict in an important way with livestock grazing.

Both game and recreation have such high public values that they will undoubtedly receive preference in the use of small areas of range land especially suited for these purposes.

World War Boom and Post-War Depression Bring Heavy Demands on Range

The participation of the United States in the World War again intensified range use by bringing about a great increase in numbers of livestock, stimulated by rising prices and by war demands for increased food production (*66*). In 1918–19, the number of animal units in the Nation was the highest ever attained (*73*), and by 1920 a great potential meat surplus had been built up. This important increase in numbers of livestock had the effect of speeding up depletion.

The additional stocking, together with dry seasons, proved a heavy blow to the program of range management on national forests. The national-forest administration responded to these urgent national demands and in 1918 allowed 1,063,000 extra animals to graze on the forests, receiving them earlier in spring and keeping them later in the fall (*69*). Justification for it lay in the fact that, although the ranges were being depleted, it was difficult to supply the meat demands of the war period. In addition there was the desire of stockmen to benefit by the high war prices. In places the damage done to the national-forest ranges has not as yet been fully repaired.

Also between 1910 and 1929, but mostly after 1915, some 50 million acres of range land, largely on the Great Plains, was plowed up for dry farming by a horde of new farmers. Later many of these farms were abandoned.

During the World War and in the post-war inflation period, as in the boom of 1863, the easy credit available led to overborrowing,

Owners were making so much paper profit that overinvestment in livestock, land, and improvements resulted. From March 1920, scoured wool dropped from $2.05 a pound to 96 cents in August 1921, and as a result sheepmen lost heavily by liquidation and foreclosure (*135*). Wool and sheep prices recovered markedly during 1922 and 1923, but cattle prices on the Chicago market dropped from more than $91 a hundredweight in 1919 to just more than $9 in 1921 and 1928, entailing a long period of deflation in cattle values and heavy losses during liquidation of assets. Afterward, along with other industries, all livestock prices rose sharply to the 1929 crest.

In 1930, the mortgage debt was 35 percent of the total value of outfits, and this percentage mounted rapidly during the depression, owing to shrinkage in land and other values (*7*). As in other industries mortgages were often larger than the current value of property. "Paper" on livestock was also extremely prevalent, practically all outfits being heavily mortgaged in order to buy feeds during the drought. Inability to pay brought an increase in delinquencies and foreclosures. In 1932 the eleventh district of the Federal Land Bank alone had taken over 706 farms, valued at more than $3,500,000, despite the fact that banks were trying to avoid foreclosure on farms and ranches.

The break in livestock prices prevented disposal of livestock at a price that even approached production costs. With lambs and ewes bringing only a dollar a head in many range localities, and with no market at all in many others, sheep numbers greatly increased. A similar condition prevailed in the cattle industry. In spite of the increased numbers of livestock on the range, much less supplemental feed was purchased than in ordinary times, and forage yields reduced by drought were woefully inadequate to the demand for range feed.

Drought Added to Excess Stocking Works Havoc on Range

The drought of 1930–35, culminating a 10- to 15-year dry period, has given another tremendous setback to range forage production, already reduced as a result of previous long, severe, and nearly unrestricted use. The heavy load imposed by World War increases in range livestock had barely begun to lighten, when the slump in livestock prices and the drought combined to increase use and reduce forage production (*66*).

Throughout the whole history of range use the forage has been heavily used and at intervals severely so. The livestock industry at times has been badly shaken. Always, however, the industry has been able to go on, in part because of the remarkable ability of the range to recover at least a part of the values lost.

In spite of heavy use over a period of many years, the range has not been destroyed, although it has been greatly weakened. With normal precipitation, growth was increased and the splendid sod grasses at least partly refilled the bare spots. Where the grasses were killed, the ground was occupied by other plants which, though of lesser palatability and smaller forage value, the animals still ate. The recuperative powers of the better ranges are so high that their capacity to support livestock has on the whole decreased slowly.

The livestock industry also has shown a great power of resilience. After each shock of depletion, drought, or depression, new feed supplies have been found, at first by seeking new ranges, but later by growing hay and other forages and by supplementing range forage with grain, cottonseed meal, and other concentrates. Improved breeding of livestock and other adjusted production practices also helped to offset the increased feeding and other management costs. In spite of range depletion, the livestock industry has managed to survive, though usually loaded with increasing expenses.

Issues Growing Out of Range-Use History

The history of range occupancy and settlement as summarized in the previous pages indicates five issues that require earnest consideration.

DROUGHTS

History records disastrous droughts in 1886 in the Southwest; in 1888–90 in Colorado; in 1893–94 in the Plains and Southwest; in 1898–99 on the Pacific Coast; in 1903–4 from Montana to Arizona; in 1917–18 in the Southwest; in 1923–24 in the Southwest and Idaho; and in 1930–35 practically all over the range country. Although this record is not complete, it shows that intermittent drought is an inseparable problem of the range country. Since it can be neither avoided nor prevented it must be foreseen, perhaps predicted, and at all events provided for. Although determining the most feasible economic method of doing these things is no small undertaking, it is one that must be attempted.

DEPLETION

As already seen, depletion of the range forage began to be of major consequence during the boom of the eighties. Between 1890 and 1910 sheep and cattle exhausted the vigor of forage by repeated close cropping, and oversettlement trimmed away great blocks of the best range. While the conflict between large and small operators, between cattlemen and sheepmen, and between settlers and stockmen for possession of the range intensified its use in no small degree, depletion, literally everywhere present, weakened the position of the livestock industry. On top of this came the immense increase in animals in the war years and the debilitating effect of protracted drought, bringing stockmen to the verge of despair. History indicates that the current of depletion, which still runs strong, will continue to do so as long as present conditions are allowed to exist. With large areas 50 percent and some others 75 percent depleted, it is not too much to predict that the range will become almost destitute of forage unless a determined, unrelenting effort at restoration is begun at once.

NEED FOR BASIC TECHNICAL KNOWLEDGE

The history of range use is in part a story of failure to conserve forage supplies; to restore depleted ranges; to plan land use; to pre-

pare for drought; and to avert the effects of depression. There is an obvious need for gathering and applying new knowledge on which to base an effort to solve these problems.

TOO-SMALL RANCH UNITS

History has also disclosed the part that subdivision of land in ill-advised efforts to encourage settlement of unsuitable or too limited farm and range units has played in range depletion. These past errors in land use are not repaired by mere abandonment of farms. Further, they are thwarting efforts at progress in land planning and now rise up to plague us as problems in submarginal lands and in the resettlement of population. Some means must be sought of repairing past errors and of avoiding those likely to arise in the future.

CYCLES OF BOOM AND DEPRESSION

Stockmen have repeatedly been at the mercy of drastic price fluctuations. Breeding herds bought at high prices during a boom have led to a surplus of cattle and sheep which has accentuated the price decline after the peak (*177*), sometimes lowering it to a third of the boom value. At five different periods, the forced sale of cattle on a shrinking market made prices per head out of all proportion to costs built up largely in a period of high prices, causing debts incurred during the up-phase of the price cycle to be a double or a triple burden. The Farm Credit Administration has worked on a solution of the credit phase of this recurring difficulty.

Each of these unfavorable consequences of range use is presented in detail in this chapter.

CLIMATIC FLUCTUATIONS

By R. S. Campbell, Senior Forest Ecologist, Division of Range Research

The hardships of the great 1934 drought were too severe to leave any doubt that extreme climatic fluctuations contribute greatly to range depletion. Forage production on ranges was so scant in 1934 that wholesale removal of livestock was necessary in parts or all of nearly every Western State. Where the drought prevailed, range vegetation simply failed to produce sufficient feed to support the numbers of livestock being grazed. Tall grasses in Nebraska (*179*), grama grasses in Montana and New Mexico, and bunchgrasses in California, in the drought areas, either failed to grow or dried up early in the season.

The 1934 drought emphasized the dependence of range vegetation and its forage production upon climate, especially rainfall. It also forcibly demonstrated the natural fluctuating balance between climate and vegetation, in which range plants increase in abundance and productivity during favorable years, and decline and lose vigor in dry years. Both wet and dry years, singly or in groups, have been occurring ever since man has observed the weather, and vegetation responds to them—a factor beyond man's control. But more than anything else the 1934 drought emphasized the failure of range livestock owners to recognize the extreme fluctuations of forage with the climate, and to manage their ranges in such a manner as to meet these vicissitudes. The worst depletion that occurred in 1934, and during nearly every previous drought, was on overgrazed ranges. So many livestock grazed the scant forage during and after the drought that little or no vigor remained in the vegetation to start a process of restoration that may require decades, especially where wind and water erosion have since removed the unprotected fertile topsoil. This is in marked contrast to the recovery of forage on conservatively grazed ranges.

What happened in 1934 has happened before, and the cumulative effect is no less than widespread depletion of the range resource already outlined—devastating in its immediate effects and far-reaching in its consequences. Each time, climate has played an integral part in the depletion. It is obvious that a sound program of management to restore and maintain the range must include an evaluation of (1) climate and its fluctuations and (2) the influence of such fluctuations upon range vegetation and use.

Climatic Fluctuations on Western Ranges

The generally sparse vegetation on western ranges really is remarkably abundant when one considers that the West receives roughly about one-third as much rainfall as the eastern half of the United States (fig. 42). A line drawn through Amarillo, Tex., and North Platte, Nebr., both of which receive about 20 inches of rain-

fall annually, would separate the country into two broad precipitation zones (fig. 44). East of the line, the precipitation is over 20 inches and varies from about 35 inches in the Corn Belt from Iowa to Ohio to about 50 inches in the Cotton Belt of the South (*81*). West of the line, the rainfall is less than 20 inches except in the mountains. Over most of the range area between Kansas and California it is under 15 inches. The great semidesert region extending from southwestern Arizona to southeastern Oregon receives less than 10 inches. Precipitation in the Rocky and Sierra Nevada Mountains averages more than 20 inches, and more than 60 inches in the Cascade Range of Oregon and Washington.

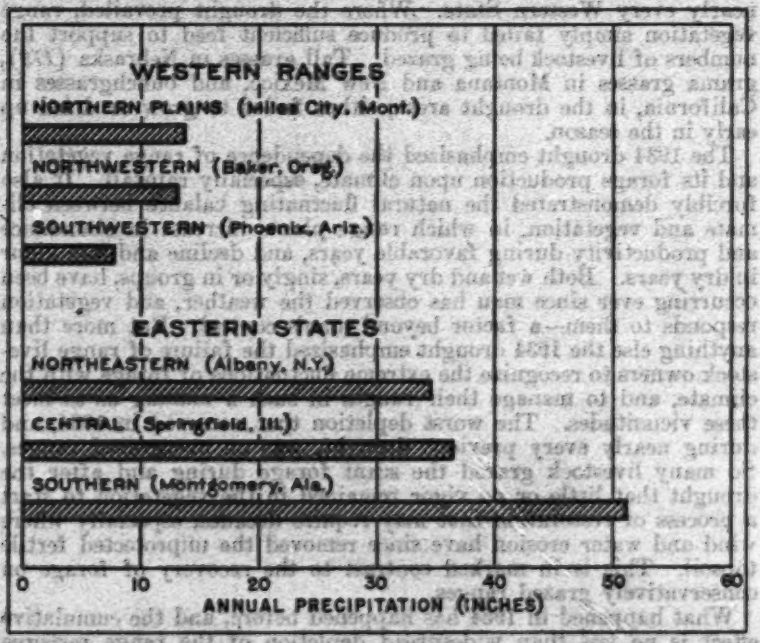


FIGURE 44.—Western ranges are characterized by low average rainfall, as shown by this comparison of precipitation of typical western stations with those in the East.

Temperatures over western ranges as a whole are no higher than in the East (*82*). However, the combination of low precipitation, high day temperatures, low relative humidity, high evaporation, high winds, and high proportion of sunshine on the western plains and semidesert lands cause plants to use the available water more quickly.

Also, the higher temperatures in the southern half of the range country make conditions for plant growth much more difficult there than in the northern portions of similar rainfall zones.

SEASONAL FLUCTUATIONS

Rainstorms a mile or more wide often move across the range for a few miles, giving one particular area a rain of perhaps a half inch

or more. A short distance away from the storm path, the soil remains dry and the vegetation is left without water. More frequently, the rain on most of the favored strip is less than 0.83 inch, and evaporates so rapidly after the storm that plants receive only a very temporary benefit. By the time such localized showers have

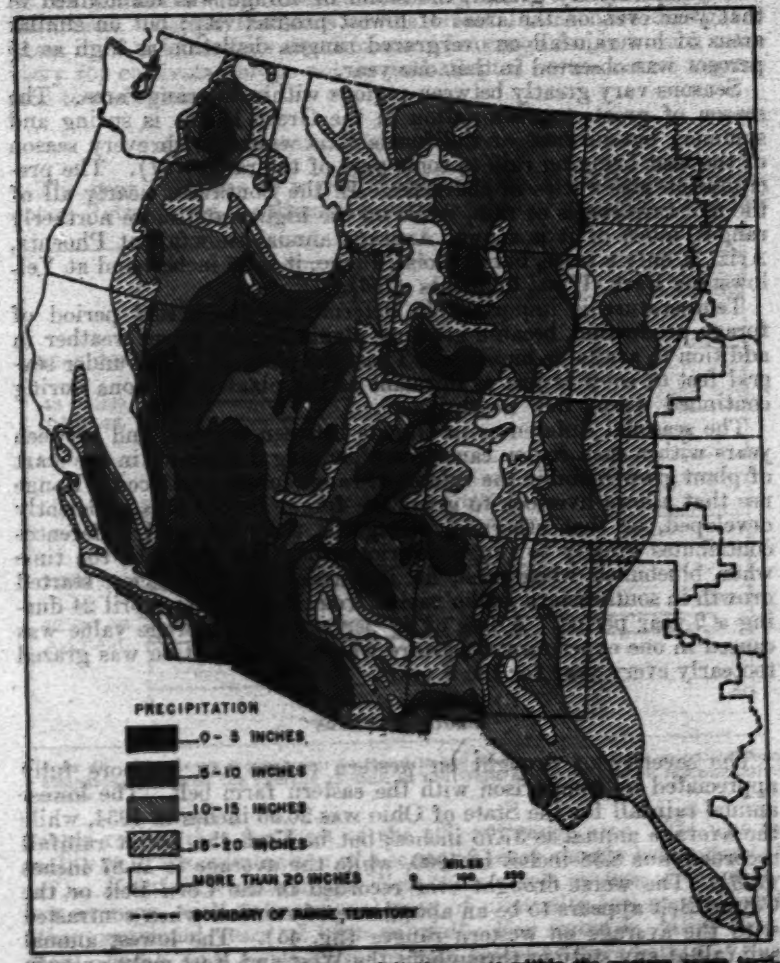


FIGURE 44.—There are several main precipitation areas within the western range territory. The desert and semidesert of the southwestern and intermountain regions are especially dry.

occurred intermittently during the summer, the range has received a greatly varying total rainfall of correspondingly uncertain benefit to the forage. On the Jornada Experimental Range, an area 20 miles square in southern New Mexico, where the average summer rainfall is 4.78 inches, Forest Service records show that actual rainfall during the summer of 1930 at different locations varied from 2.50

to 6.60 inches. Such differences, which occur even in favorable years, necessarily cause forage growth to be spotty. For example, the estimated forage crop in 1930 on the Jornada range was 100 percent where the rainfall was average or better but only 50 percent where rainfall was at the lowest point. Because the Jornada range was conservatively grazed, the stand of forage was maintained in that year even on the areas of lowest productivity; but on similar areas of low rainfall on overgrazed ranges, depletion as high as 15 percent was observed in that one year.

Seasons vary greatly between regions within the range area. The season of greatest precipitation in the Great Plains is spring and summer; but in most of California it is winter, with every season of the year bringing rain to some part of the range (*31*). The precipitation also varies in character. In the Southwest nearly all of the moisture comes as rain, while on the higher and more northerly ranges, much of it is snow. Average annual snowfall at Phoenix, Ariz., is only a trace, but at Boise, Idaho, it is 25 inches, and at Yellowstone Park, Wyo., 97 inches (*156*).

Temperature is important in determining the actual period of forage production, because growing plants require warm weather in addition to available moisture. Thus, the plant in Idaho under several feet of snow is just as dormant as the plant in Arizona during continued warm, dry weather.

The seasonal differences in climate between regions, and between years within each region cause corresponding differences in the start of plant growth and in the volume of range forage produced. Range use that allows livestock to graze the forage before it is sufficiently developed, or that otherwise disregards these seasonal differences contributes greatly to range deterioration. For example, the time when bluebunch wheatgrass, an important forage species, started growth in southeastern Idaho varied from March 20 to April 24 during a 9-year period. A loss of 49 percent of the forage value was caused in one experimental pasture where the vegetation was grazed too early every year for the 9 years.

DROUGHT YEARS

The severity of drought on western ranges can be more fully appreciated by comparison with the eastern farm belt. The lowest annual rainfall for the State of Ohio was 26.56 inches in 1934, while the average annual is 37.75 inches; but in Utah the lowest rainfall recorded was 8.38 inches in 1900, while the average is 12.87 inches (*156*). The worst drought ever recorded in the Corn Belt or the Cotton Belt appears to be an abundance of rainfall when contrasted with the average on western ranges (fig. 45). The lowest annual rainfall at any stations throughout the West and East make an even more striking contrast. For example, the lowest rainfall ever recorded at Des Moines, Iowa, was 18.24 inches in 1910, or 57 percent of average; but at Miles City, Mont., rainfall during the 1934 drought was only 5.51 inches, or 40 percent of average.

Drought is both severe and frequent on the western range. Using 75 percent of the average annual precipitation as an arbitrary criterion of drought for the range country, more than 3 years out of

every 10 are drought years over great areas, according to calculations which include only 1933 and thus exclude the severe 1934 drought (fig. 46). The Mohave-Gila Desert has drought 4 years out of 10, or nearly every other year, which alone labels it as the most unreliable country for grazing in the West. The semidesert ranges of the Southwest and Intermountain regions are only slightly less hazardous. Certain portions of the Great Plains have drought 3 years in 10, a hazardous situation even for range use, but much more risky for cultivated crops not as well adapted as the native vegetation to such vicissitudes.

THE MENACE IN A RECURRENCE OF DRY YEARS

The year 1934 was so severe that it focused the attention of the entire Nation upon the disastrous consequences of drought. But few

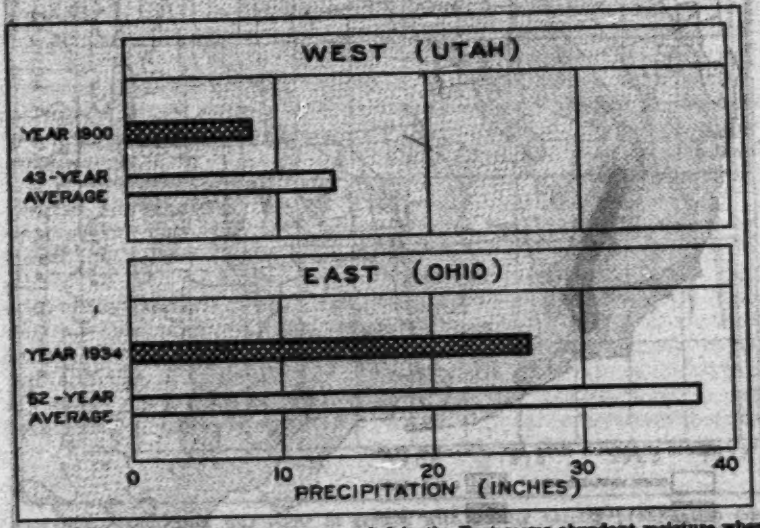


FIGURE 45.—The worst drought ever recorded in the East seems abundant moisture when compared with even the average rainfall in the West, as shown by two representative States.

people realize that for most of the afflicted range area, 1934 was in reality only the culmination of a series of years, mostly below normal (17). Rainfall records in the West show whole groups of years below average, with an occasional year of unusually low rainfall and other occasional years of high rainfall. For example, Miles City, Mont., had a long series of years with below-average rainfall from 1880 to 1905, and again from 1917 to 1934 (fig. 47).

There is hardly a year when it is not dry somewhere in the country, but the outstanding recent periods when dry years have occurred in one or more western regions include 1888 to 1890, 1892 to 1894, 1898 to 1904, 1910, 1917, 1919, 1924, and 1928 to 1934, inclusive. According to the statements of early settlers and actual records in recent years, most of these dry years contributed to the decline of the

range, and this decline was undoubtedly accentuated by overstocking which did not take into account sufficiently the effect of drought on the vegetation.

The periodic recurrence of wet and dry years suggested by available precipitation records is confirmed by the tree-ring studies of Douglass (*49*). Since trees ordinarily add a new ring of wood each

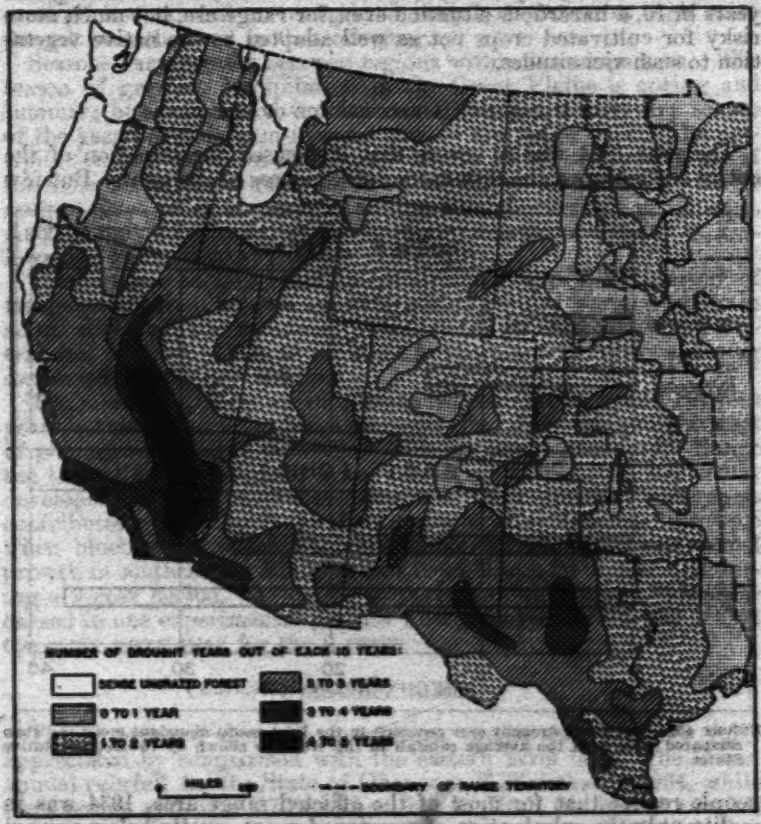

NUMBER OF DROUGHT YEARS OUT OF EACH 10 YEARS:
SEMIARID UNGRAZED FOREST
0 TO 1 YEAR
1 TO 2 YEARS
2 TO 3 YEARS
3 TO 4 YEARS
4 TO 5 YEARS
MILES
BOUNDARY OF RANGE TERRITORY

FIGURE 42.—DROUGHT FREQUENCY ON THE WESTERN RANGE.

The southwest and intermountain desert and semidesert ranges suffer drought (precipitation 75 percent of average or less) more frequently than other regions. (Based on 30-year averages 1899–1928, inclusive; calculations supervised by U. S. Weather Bureau.)

year, and the width of each ring corresponds to the precipitation available that year, with an accuracy of 70 to 85 percent, the tree-ring record gives good indication of the climate. In the case of the sequoias of California, the data extend as far back as 1310 B. C. and indicate cycles of 11 years. Dry years as shown by poor growth of ponderosa pines in the area of Flagstaff, Ariz., occurred in 14- and 21-year cycles, with major droughts about every 150 years, and minor droughts at 40- or 50-year intervals.

Periods of poor growth in ponderosa pine forests in the Pacific Northwest were found to vary from 3 to 14 years between 1630 and 1930 (*89*). With such considerable variance in the periods of dry years, it is not possible to predict the exact rainfall for any single year in the future, although some progress has been made in this line (*4*). The outstanding fact is that dry years and the accompanying reductions of forage production and grazing capacity occur with such frequency that good range management requires stocking the range on a basis sufficiently conservative to avoid severe drought losses or forced sales.

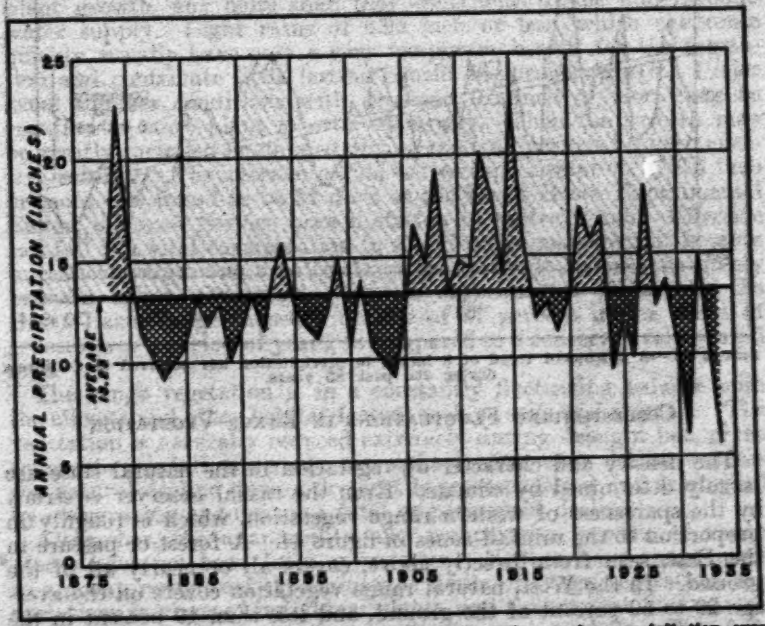


FIGURE 47.—Dry years may occur in groups, with greatly varying precipitation even during generally favorable periods, as shown by actual rainfall records at Miles City, Mont., a representative station for the range country.

PROGRESSIVE DEFICIENCIES

It is serious enough to have to plan for 3 or 4 years out of every 10 having less than average rainfall, but the longer weather cycles are particularly disheartening and require even more careful planning of range use. For example, Forest Service compilations show a decided downward trend in precipitation for the entire Intermountain Region since about 1908. In California there was a downward trend of 8 inches during the 80-year period from 1850 to 1930 (*61*), and further calculations show that the trend prevailed through 1934 (fig. 48). Such deficiencies may represent only the drier portions of long precipitation cycles, and it is possible that the trend may turn and continue upward for several decades. However, when progressive moisture deficiencies accumulate over the active span of 2 or 3

generations, even the peaks of short-term cycles need to be discounted in management plans that are to provide for avoiding excessive depletion. There is little question that this long-time deficiency in California has contributed to a depletion in that State of nearly 45 percent on private ranges and more than 50 percent on State and public-domain ranges.

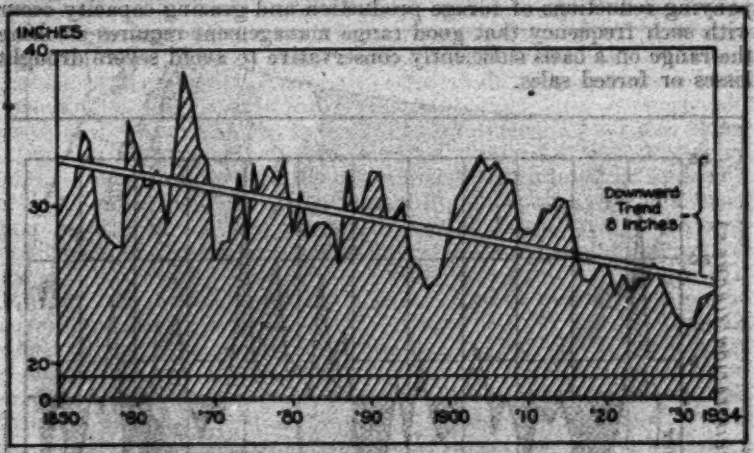


FIGURE 43.—A downward trend of 8 inches in precipitation has occurred in California during the past 85 years.

CORRESPONDING FLUCTUATIONS IN RANGE VEGETATION

The density and character of vegetation in the natural state are largely determined by climate. Even the casual observer is struck by the sparseness of western range vegetation, which is roughly in proportion to the rainfall zones in figure 44. A forest or pasture in the East, seen from directly above, covers all or nearly all of the ground. In the West, natural range vegetation covers on the average 20 to 50 percent of the ground, and less than 10 percent in the desert areas.

The adaptability of the individual plant to fluctuating climatic conditions, including the power of recuperation after severe loss of vigor during drought, is probably the most striking feature of western-range vegetation. Adjustments in the structure of plants which adapt them to dry climate, and which result in lower or more efficient water use, include reduced size, both of the whole plant and of the various parts, such as stems and leaves, thorns, hairs, resin, and wax on the stems and leaves, leaves that curl or fold, and leaves that drop off quickly, as in most cacti.

Many range plants make very effective use of the available water. Some of the native grasses require less than 400 pounds of water to produce one pound of dry plant material—in decided contrast with the requirements of many cultivated crops. The water requirement for alfalfa is over 800 pounds, and higher for some other plants (*196*). Moreover, Forest Service experiments in central

Arizona have indicated that transpiration from native shrubs and grasses during the summer is only 10 percent greater than evaporation from bare soil.

In spite of all these unusual characteristics of range plants, however, they have decided limits of endurance. There is a rather definite point in the drying of each kind of soil at which plants wilt, according to Briggs and Shantz (*60*). Most plants in the semidesert type wilt temporarily every afternoon during the summer.

Adequate soil moisture is determined very largely by the frequency of effective rainfall. Many light rains are not effective in promoting plant growth, any more than they contribute to the underground water supply. Light rains of 0.25 inch or less, which evaporate quickly, usually have only a very temporary benefit for the vegetation and contribute little lasting benefit to forage growth. Under usual summer conditions with dry soil, 0.5 inch or more may be required to start plant growth effectively. Then the growth may be greatly curtailed or stopped during the long periods between effective rainfall. The average period between precipitation of 0.5 inch or more was found to be 34 days at the Great Basin Experimental Range, a Forest Service branch station in central Utah. Effective rainfall is a vital consideration in sound range management because in reality overgrazing usually allows the forage to be used too closely between rains. Overgrazing on an experimental pasture at the Great Basin range caused a decline of 57 percent in the stand of grasses over a period of years, as compared to a conservatively grazed area.

The range vegetation is in a constantly fluctuating balance with the climate and other habitat factors such as soils and animals. The vegetation is naturally reduced extremely during drought but, given favorable rainfall, the range comes back after each decline—unless the natural decline during drought is so emphasized and intensified by overgrazing as to cause a fatal or permanent decline.

Altogether, the adaptability and recuperative powers of range plants have not been fully appreciated. Neither have range users as a group recognized the endurance limits of range vegetation, the variations in vigor of individual plants, and the extreme fluctuations in forage productive capacity over the range as a whole. This failure to recognize the fundamental nature of the resource has more than fully discounted the recuperative abilities of range forage under existing climatic conditions and has been a major factor in the range depletion outlined in other sections of this report.

RANGE FORAGE PRODUCTION DECLINES IN DRY YEARS

Forage production varies greatly from year to year. The volume of range forage produced is actually made up of growth made by plant parts which livestock relish and eat readily. By and large, the grasses, especially perennials, furnish the bulk of the feed, so that measurements of forage production are usually based mainly upon the growth made by the existing stand of grasses. But the stand itself fluctuates greatly. During the 1933–34 drought, 74.8 percent of the short grass plants were killed on overgrazed experimental pastures in western Kansas and 64.6 percent on moderately grazed areas (*122*).

Fluctuations in height growth of key range grasses effectively show the nature of the problem which must be faced each year in range use. For example, height growth of Smith's wheatgrass near Miles City, Mont., was 13 inches in 1933, 1 inch in 1934, and 15 inches in 1935, according to Forest Service measurements. Height growth of grasses has been shown to have a close relationship to rainfall in numerous other Forest Service experiments (*93, 80, 116*).

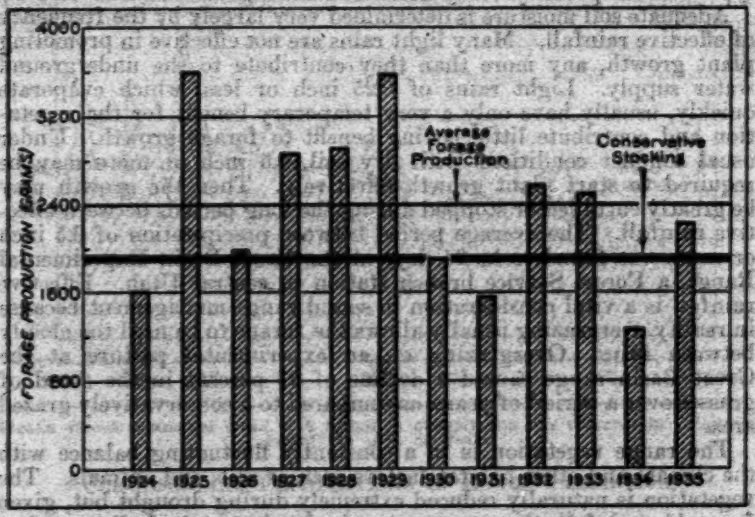


FIGURE 49.—Range forage production fluctuates so greatly from year to year that conservative stocking must be 20 percent or more below average production to furnish adequate forage in all but lowest years.

The variations in the height growth of grass are indeed considerable, but the variations in actual amounts of forage produced are even more startling. In Forest Service studies of important forage plants in several parts of the West, production of black grama in southern New Mexico varied from 98.9 grams per square meter in 1926 to 1.1 grams in 1928, with no production in 1934; Rothrock's grama in southern Arizona varied from 66.1 grams in 1927 to 6.9 grams in 1928; and mixed grasses in eastern Montana varied from 178.2 grams in 1927 to 24.9 grams in 1934. Mixed perennial grasses in central Utah varied from 3,598 grams per square rod in 1925 to 1,276 grams in 1934, with an average production of 2,379 grams over a 12-year period (fig. 49). It is obvious that stocking the range on the basis of average forage production would have provided adequate range feed in only 6 of the 12 years. Conservative stocking at approximately 20 percent below the average would have provided adequate forage in 9 years. This would have left considerable surplus feed in some years, which in itself is a form of insurance against inadequate range-feed production during drought.

The quantity of reserve range feed needed varies somewhat in different regions depending in part upon the relative frequency and severity of drought. Conservative stocking at a point 25 percent

below the average has been recommended by the Forest Service for the semidesert grass type (*31*).

On a national-forest range in central Utah, where conservative grazing has taken the forage fluctuations into account, the stand of forage has been improved 100 to 200 percent on spring ranges, and as much as 400 to 500 on depleted parts of the summer range, since the range was put under management (*154, pp. 550–554*). On the other hand, potentially better privately owned range areas in Ford and Parrish Canyons, subject to similar climate, but continually overgrazed for at least 10 years, were found to have lost 75 to 85 percent of the original total vegetation by 1930 (*10*).

EFFECT OF DRY SEASONS ON GRAZING USE

Climate largely determines the seasons of the year when range use is practicable. It is only natural that livestock owners should graze their animals on the range, where feed is cheap, as long as possible. However, snow and stormy weather usually prevent winter grazing on the high mountain ranges, although at lower elevations winter or yearlong grazing is often practiced. All in all, the critical seasons of the year on the range usually coincide with the occurrence of dry or otherwise unfavorable climatic conditions.

In the Southwest, the spring is ordinarily the most difficult season for range vegetation, as well as for range livestock. Temperatures rise sufficiently high to permit vegetative growth, but the necessary moisture is usually lacking. The soil and air are exceedingly dry, and winds often blow day after day. The dry soil loosened by grazing animals blows away from some plants exposing their roots and is deposited on others. On the Jornada range in southern New Mexico the black grama grass on several thousand acres of range was covered over and killed by deposits of several inches of sand blown from an adjacent severely overgrazed range in 1917 and 1918. During the drought, unmanaged range, heavily overgrazed, especially in the spring, declined 81 percent in comparison with a decline of 58 percent on the more conservatively grazed Jornada range (*93*).

The problem of adequate range forage during the spring and fall seasons is also serious in the intermountain region. Spring feed is especially important to give lambs and calves a proper start. A conservative grazing system introduced experimentally by the Forest Service at the United States Sheep Station in southeastern Idaho brought about a 15-percent improvement in spring-fall ranges in 9 years. Sheep were turned onto the range in the spring only after soil moisture and rising temperatures had allowed the bunchgrasses to become well started. In the same 9 years, forage production declined 50 percent on unmanaged range where too many sheep were placed on the range too early in the spring and were allowed to overgraze the vegetation.

VEGETATIVE STAND DECREASES AFTER DROUGHT

In 1935 the stockmen and others in many sections of the West were surprised by what appeared to be quick recovery of range vegetation from the severe 1934 drought. Once again, just as in

previous decades, came overconfident statements to the effect that only a few more drops of rain are all that the West needs to "bring the range back" (*5*). What actually happened was rather less reassuring than what was popularly assumed to have occurred. True, grasses made good height growth over most of the West where good rains fell. For example, the height growth of spiked wheatgrass in southern Idaho was 8 inches in 1935 as compared to 4.6 inches in 1934, and black grama in southern New Mexico was 16.1 inches in 1935, as against 2.2 inches in 1934. But the stand or density of vegetation was far from being brought back, especially on overgrazed ranges. Measurements in 1935 showed that the grass density even on plots protected from grazing declined 77 percent as a result of the 1934 drought in central Arizona. Measurements at several locations in the West showed that as a result of the 1934 drought, the density of grama continued to decrease in 1935 even

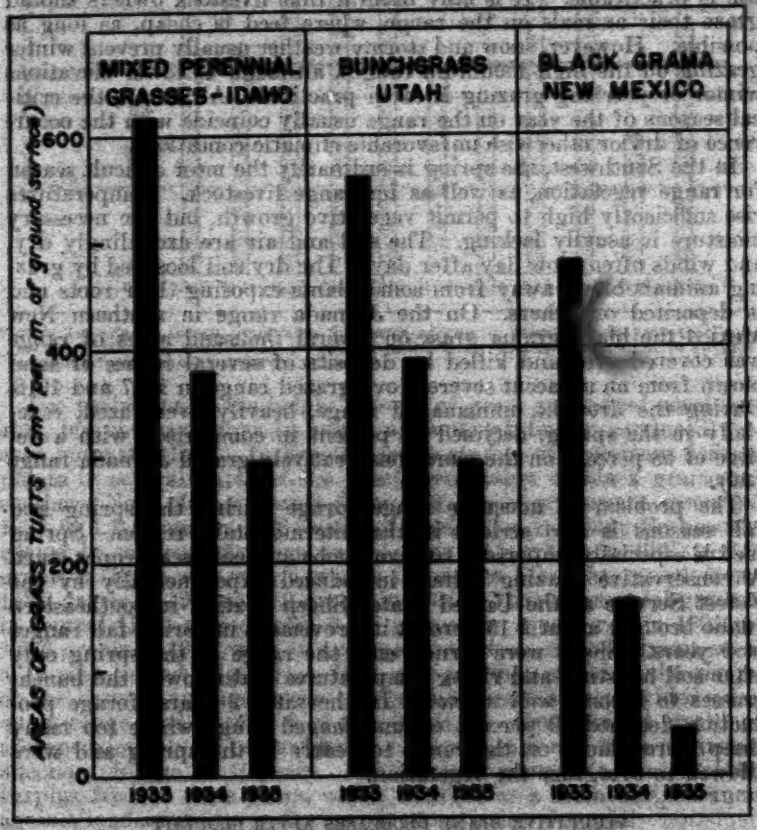


FIGURE 80.—EFFECT OF DROUGHT ON AREA OF GRASS TUFTS.

The density of vegetation continued to decline in 1935 in all of these three regions, as a result of the 1934 drought, even on ungrazed plots.

on ungrazed plots, although the 1935 rainfall was about normal (fig. 50). Those who saw "recovery" in 1935 failed to realize that livestock cannot thrive permanently on a single year's good height growth produced by a stand of vegetation thinned and weakened by drought and overgrazing. It requires both a good stand or density of vegetation and height growth to produce the volume of forage necessary for stabilized range use. Forest Service studies show that it takes 3 to 5 years of favorable precipitation to restore drought-depleted stands of sod-forming grasses and good-seeding bunchgrasses even under conservative grazing. Unfortunately, the types containing poor-seeding bunchgrasses are widespread in the West and have continued to deteriorate, as shown in previous sections.

The continued decreases in stands of range forage observed in 1935 confirm studies on the Jornada Range in southern New Mexico, which show that the stand of black grama increases or decreases in accordance with the rainfall for the previous year (*95*). Thus unusually low rainfall in 1921 caused a decrease of 89 percent in the stand on ungrazed plots during the 2 years 1922 and 1923. The loss was largely restored by 1926 under higher rainfall. Measurements during the same period on range overgrazed year after year showed that the black grama was completely killed out during the drought of 1922 and 1923, and was replaced by snakeweed and other worthless or poor forage plants during the following years of higher rainfall.

CYCLIC FLUCTUATIONS IN VEGETATIVE GROWTH

The foregoing examples indicate the nature of the cyclic trends in the stand of range vegetation. Just as the volume of wood grown each year by a tree (as indicated by the thickness of tree rings) reflects the annual and cyclic variations in precipitation, so the range vegetation fluctuates from year to year and over periods of dry and wet years.

Fluctuations in density of range vegetation, broadly corresponding to increased or decreased precipitation, have been observed in many parts of the West. For example, a stand of mixed perennial grasses in southern Idaho varied from 969 cm³ per square meter in 1926 to 296 cm³ in 1935. A similar stand in central Utah varied from 774 cm³ in 1931 to 295 cm³ in 1934. A bunchgrass type in northern Arizona varied from 856 cm³ in 1919 to 2,666 cm³ in 1930. The stand of vegetation may recuperate wonderfully in good years only to decrease again during drought. Overgrazing or other practices which fail to accord with good range management and violate the scheme of nature so impair the vegetation that instead of recuperating during years of favorable rainfall, it actually regains very little of its original stand and then declines further in the next drought. Forest Service studies on western Utah winter ranges show that the drought from 1931 to 1934 caused a 20-percent decrease in available forage plants on ungrazed plots, but on overgrazed areas within a few miles of water, depletion was approximately 60 percent (*198*).

Severe drought also affects the soil unfavorably. The stand of vegetation is so reduced that the unprotected soil is exposed to greatly

accelerated erosion by both wind and water. The now famous "dust bowl" of western Kansas and eastern Colorado is an extreme example of wind erosion during and following drought. The removal of the fertile upper soil layers exposes the raw subsoil and makes it just so much more difficult to restore the range vegetation. Accelerated water erosion, which is more fully discussed in another section, is fully as detrimental to range productivity as wind erosion.

That actual management of livestock on the range has utterly disregarded the probability of recurrent drought is shown by a comparison of livestock numbers with rainfall. In New Mexico, for example, the major peaks in livestock numbers correspond with the major drought periods. Although rainfall steadily decreased from 1931 to the low point in 1934, livestock numbers continued to increase during the entire period (fig. 51). On January 1, 1934, after one dry year and at the beginning of one of the worst drought years ever recorded in the State, livestock numbers were at the highest point in over a decade. The Government relief purchases in the summer of 1934 automatically reduced livestock numbers and absorbed some of the losses that private owners otherwise would have suffered.

The same sort of thing happened in New Mexico in nearly every drought period. Although rainfall dropped abruptly during 1916 and 1917, livestock numbers increased in those two years and dropped off rapidly in 1918 and 1919. Again, the rainfall decreased greatly during the period from 1920 to 1922, but livestock numbers increased during 1920 and 1921 to a peak on January 1, 1922, then dropped off sharply through wholesale starvation losses and distress sales during the culmination of the drought in 1922 and early 1923. Undoubtedly the ranges were badly depleted in 1917 and 1922 so that the peak of livestock numbers in 1934 was considerably below the preceding two high points. The records for other States and for the entire western range area show much the same thing.

Some vegetative types are much more susceptible to depletion during drought than others. A conservatively grazed black grama type in southern New Mexico declined 77 percent from 1933 to 1935, and a lightly grazed short-grass type in eastern Montana declined 67 percent, but a mixed perennial type in the Wasatch Mountains of central Utah declined only 48 percent during the same period. Forest Service records of these areas during previous droughts indicate similar relationships. Stands of vegetation which vary most offer least resistance to continued depletion as a result of overgrazing. This factor of susceptibility to depletion must be taken into account in any program of use adjustment.

Climatic Guides to Permanent Range Use

The delimitation of the range area and of definite regions in which range or agricultural use is particularly hazardous, is a necessary step in any forward-looking land-use program. Final fixing of the boundaries of marginal and submarginal areas will, of course, be dependent upon economic and other considerations, but climate alone can indicate broad regional characteristics of suitability for grazing and cultivation.

For example, the annual rainfall is below 5 inches over much of the Mohave-Gila Desert in southwestern Arizona and southeastern

California. The available soil moisture there is simply too scant to support sufficient palatable vegetation, and the supply of water for livestock is so scarce that little attempt has been made to graze large areas. Although the desert may furnish occasional winter grazing, it is not dependable.

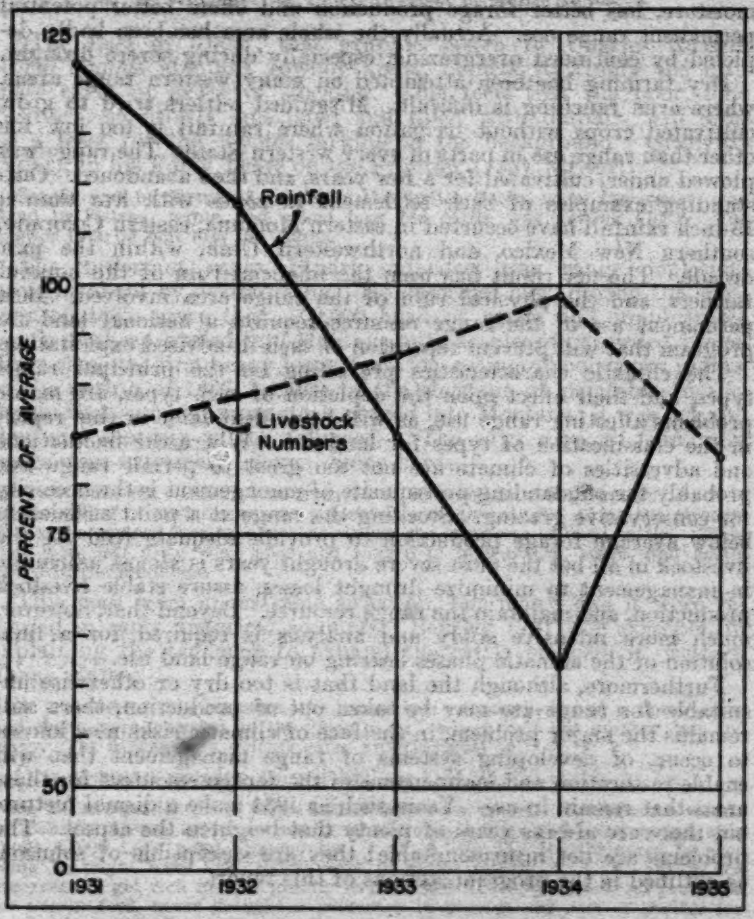


FIGURE 51.—STOCKING NOT ADJUSTED TO RAINFALL.

Livestock numbers increased in New Mexico during each of three such major drought periods as that of 1932–34, shown above. A typical example of the stocking of ranges without regard for natural fluctuations in range forage production. (Percentages are based on average annual precipitation and on animal units as of January 1 for the period 1916–30.)

Adjacent to the desert is the zone with 5 to 10 inches of rainfall extending from south-central Arizona as far north as Boise, Idaho. Nearly all of this great semidesert area is grazed at some time during the year, but drought is frequent and the range types are very susceptible to depletion, facts which explain why the area de-

teriorated so greatly during the major droughts of 1893, 1903, 1924, 1928 to 1931, and 1934. All of these factors combine to indicate that at least the drier part of the southern half of this great semi-desert zone may be marginal for permanent ranching. The northern half, where cooler temperatures encourage longer retention of soil moisture, has better forage production and offers better potential permanent range use. Actually the whole area has been badly depleted by continued overgrazing, especially during severe drought.

Dry farming has been attempted on many western range areas, where even ranching is difficult. Misguided settlers tried to grow cultivated crops without irrigation where rainfall is too low for other than range use in parts of every western State. The range was plowed under, cultivated for a few years, and then abandoned. Outstanding examples of such settlement in zones with less than a 15-inch rainfall have occurred in eastern Montana, eastern Colorado, southern New Mexico, and northwestern Utah, within the past decade. The net result has been the financial ruin of the hopeful farmers, and the physical ruin of the range area involved. Best permanent use of the range resource requires a national land-use program that will prevent repetition of such ill-advised exploitation.

The climatic characteristics prevailing on the principal range types, and their effect upon the depletion of such types, are major problems affecting range use, as will be evident later in this report in the classification of types for land use. Where the fluctuations and adversities of climate are not too great to permit range use, probably the outstanding prerequisite of management is the necessity for conservative grazing. Stocking the range at a point sufficiently below average forage production to provide adequate feed for the livestock in all but the most severe drought years is almost axiomatic in management to minimize drought losses, assure stable livestock production, and maintain the range resource. Beyond that, however, much more intensive study and analysis is required for a final solution of the climatic phases bearing on range land use.

Furthermore, although the land that is too dry or otherwise unsuitable for range use may be taken out of production, there still remains the major problem, in the face of climatic risks now known to occur, of developing systems of range management that will enable restoration and maintenance of the forage resources for those areas that remain in use. Years such as 1934 make a dismal picture, but there are always years of plenty that brighten the aspect. The problems are not insurmountable; they are susceptible of solution, as outlined in the program sections of this report.

EXCESSIVE STOCKING

By W. R. Chapline, Chief, Division of Range Research

"The Last of 5,000", that graphic sketch by Charles Russell, world-famous Montana cowboy artist, depicts strikingly the ultimate effect of excessive stocking. One feels that the poor, lone "critter", so utterly emaciated and filled with despair, will soon be a feast for the coyotes lurking in the background. Granville Stuart, in his Forty Years on the Frontier (*138*), writes:

> Charlie was in charge of a herd in the Judith Basin, when the owner, who lived in Helena, wrote and asked how his cattle was getting along. For answer Charlie sent him the sketch.

The important cause, Stuart indicates, was range depletion, brought about by overstocking. He describes how, during the summer of 1885, more than 100,000 head of cattle and innumerable bands of sheep trailed into Montana onto an already crowded range. Then came the first heavy losses from the eating of poisonous plants, in the spring of 1886, because of the shortage of palatable forage. Again that summer, more stock poured into Montana; it was hot and dry, and a severe winter followed. "The cows were all thin" and losses were extremely heavy. Some herds—

> perished outright. Others lost from 75 to 80 percent of their cattle. * * * In the spring of 1887 the ranges presented a tragic aspect. Along the streams and in the coulees everywhere were strewn the carcasses of dead cattle. Those that were left alive were poor and ragged in appearance, weak, and easily mired in the mudholes.

This may seem an extreme situation, but many like it were recorded in early historical accounts. Bentley (*16*), for example, in explaining the tendency to expand the cattle business in western Texas, states:

> As a result of this madness, the range was overstocked, and a dozen cows and sheep were crowded on the "free grass", where half the number was too many. The ranges were quickly eaten and trampled out. * * *

One cowman decided to sell his herd of 25,000 cattle in 1882:

> He did not get his price, hence had to hold over his herd through the winter of 1882–83. It was an exceptionally severe one, and the following spring only about 10,000 head were rounded up. * * * On the 100,000 acres he was using he might have held 10,000 head of cattle safely, * * * but in his eagerness to get rich fast he greatly overstocked the range, made no provision for winter feed, never thought it necessary to provide any sort of shelter for his stock, and suffered the inevitable consequences of this reckless way of doing business.

Gordon (*58*), in a special report on the range area accompanying the Tenth Census in 1880 considered some ranges overstocked and depleted even then. He referred to these conditions in such statements as the following:

> The best quality of pasture of today (in Colorado) is only comparatively good, the best quality of 20 years ago having been essentially changed. * * * The character of the natural grazing in southwest Montana has greatly depreciated. Stockmen of the longest experience reported that a cow ranged 50

acres to find what grew on 20 acres 6 years ago, and on 5 acres in 1870. * * * "Free range" * * * resulted in excessive grazing, and rendered many wide areas of Nevada south of the Humboldt River wholly unfit for more than a limited stock occupancy.

Thornber (*144*), in describing the early situation in Arizona, stated:

> The serious consequences attending the grazing, ultimately, of nearly double the number of stock on the ranges that could be carried safely year after year, culminated in the disastrous droughty period of 1891 to 1894. * * * With a general shortage of feed and water on the ranges, stock died off on every hand. It is estimated that over 250,000 cattle, out of somewhat more than 800,000 all told, perished on the ranges in Arizona alone during the period of 1891 to 1894, not to mention the number of sheep and other grazing animals. In many localities from 25 to 50 percent of the stock died from starvation, while as many more were left in such condition as to require a season for recovery.

President Theodore Roosevelt's commission to study the land situation and to make recommendations for the best utilization of the remaining public domain, after an exhaustive study including 1,400 answers to a circular letter addressed to stockmen throughout the West, reported in 1905 (*146*), in effect, that the general lack of control of the range lands had resulted in overgrazing and in the ruin of millions of acres of otherwise valuable grazing territory.

There can be little question but that these writers and the Roosevelt Commission were convinced that during the eighties, nineties, and early 1900's, ranges were excessively stocked and were being depleted as a result.

The range wars of these early days were still another symptom of overstocking. Had range feed been sufficiently abundant to meet the needs of all the livestock that new settlers and stockmen aspired to graze, little reason for conflict would have developed. However, when the established stockmen witnessed the invasion of "trespassing" herds and saw their winter's feed supply vanishing, as hungry animals consumed every vestige of forage, deadly strife resulted.

Has excessive stocking, the grazing of more livestock or other animals on a range in any year than the available range feed can sustain year in and year out, continued on range lands, and has it caused range deterioration? Some stockmen and others are not convinced that it has. The serious and widespread depletion of range lands has already been pointed out. If excessive stocking has been responsible, at least in part, and if present stocking constitutes overstocking, there should be evidence to prove it.

Evidences of Excessive Stocking

Evidences of excessive stocking include such features as:

(1) The inability of the range to support the large numbers of livestock carried since about 1890 within the range area, indicated in two ways—by an increasing use of feeds other than range forage, and by a declining trend in numbers of livestock grazing range lands.

(2) Deterioration of the range itself, which is not alone due to climate.

(3) Present stocking considerably in excess of estimated grazing capacity.

(4) Serious losses and other unsatisfactory production as a result of range feed shortage.

NUMBERS OF LIVESTOCK WITHIN RANGE AREA

In order to get at the evidences of excessive stocking, it is necessary to consider first the numbers of livestock which have been carried within the range area.

The approximate numbers of livestock,[11] expressed in animal units,[12] from 1870 to 1935, within the 11 far-western States and the range portion of the six Plains States, are shown graphically in figure 52.

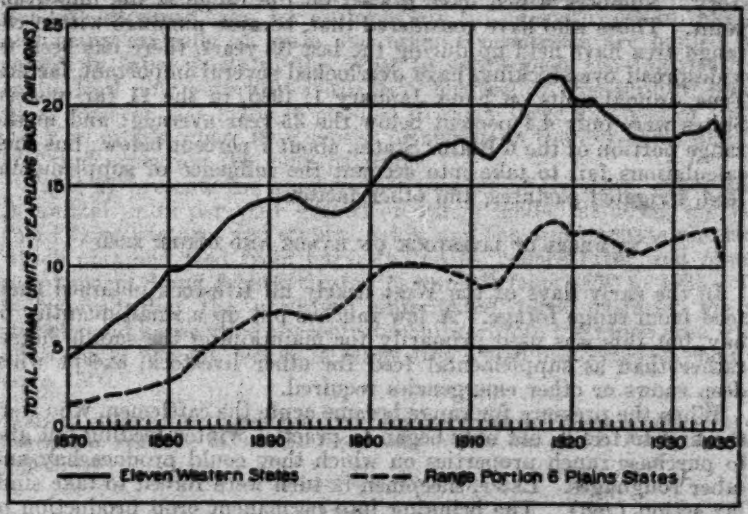


FIGURE 52.—Trends in total animal units in the range country.

Even in the face of severe losses in critical periods, numbers of livestock show a rising trend for the first 48 years. Starvation and winter losses of the eighties were soon forgotten; those stockmen who still had a remnant on which to build and new settlers with capital brought in from the East forced numbers on upward. Livestock were pushed back into the less accessible mountain ranges and into the poorly watered desert areas. The depression, drought, and lack of range feed of the early nineties again took their toll and halted the upward trend for a few years, but another upward surge, principally in sheep, brought a new high peak about 1908.

A still higher peak was reached in 1918, the result of the World War urge for increased production and the encouragement of high

[11] The yearly estimates of numbers of livestock in the range area are derived from the published revised estimates of the Bureau of Agricultural Economics for the 17 Western States for January of each year from 1919 to 1935, and before that time, from unpublished revisions by that Bureau where available, and other similar revisions based on original published estimates of the Department of Agriculture and Census records. For the range portion of the six Plains States, the January 1 estimates for census years were determined by using a proportionate ratio of census numbers in counties in the range area to that for the whole State. Although these numbers cannot be considered as accurate for all years, they do show with reasonable accuracy the main trends for the period under consideration.

[12] An animal unit for purposes of this report is considered to be one head of cattle, one horse, one mule, five sheep, five swine, or five goats. The ratio of five to one was considered a suitable average of the generally lower ratio between cattle and sheep on the range, which in places is found by the Forest Service to be as low as three to one, and the higher ratio between cattle and sheep in the feed lot used by animal husbandmen.

prices and easy credit. At that time there were approximately 13,254,000 cattle, 22,457,000 sheep, 3,347,000 horses and mules, and 3,565,000 swine and goats in the 11 far-western States. At the same time, in the range portion of the six Plains States there were approximately 8,082,000 cattle, 1,478,000 sheep, 2,837,000 horses and mules, and 5,276,000 swine and goats. Since the war there has been a declining trend in livestock numbers with an abrupt drop in 1934.

Total number of animals within the range area is not an entirely reliable criterion of overstocking since it does not tell the whole story. Numbers which have grazed on the range is the important point. Those who have considered that, because numbers within the range area have held up during the last 35 years, there has been no widespread overstocking, have overlooked several important factors. True, animal units on hand January 1, 1935, in the 11 far-western States were only 4.4 percent below the 35-year average; and in the range portion of the 6 Plains States, about 7 percent below; but such calculations fail to take into account the influence of supplemental feed, irrigated pastures, and other factors.

NUMBERS OF LIVESTOCK ON RANGE AND OTHER FEED

In the early days of the West nearly all livestock obtained their feed from range forage. A few ranches put up a small quantity of hay, but this was used primarily for maintaining the saddle horses rather than as supplemental feed for other livestock, except when deep snows or other emergencies required.

When the pressure for range became acute the cattlemen, who were the first to feel it, not only began to practice winter feeding but also to purchase ranch properties on which they could produce hay and other roughages. Later, sheepmen in turn were forced to take similar action (*166*). The bringing into permanent crop production of about 100 million acres in the West cut into the more desirable range areas but made available large quantities of supplemental feeds and also much stubble for grazing.

In 1890 there was only 34,687,000 acres of improved farm land of all kinds in the range area, with a little over 3,600,000 acres irrigated; improved pastures were not abundant, and there was relatively little shipment of concentrates into the range country. By 1930 the cultivated area was nearly three times as great as all improved land in farms in 1890; hay and other forage-crop production was nearly five times as great; irrigated land had also increased fivefold; improved pastures were common on farms, and millions of acres of wheat and other grain stubble were used for grazing. Several million tons of grain, cottonseed cake, linseed meal, and other concentrates are now produced or shipped into the range area for feeding. Other products used for feeding have also become of vast importance, such as ensilage, beet pulp, pea vines, bean straw, fish meal, and rice and fruit byproducts.

While part of this feed has been used to safeguard against losses from inclement weather and because of changed production practices in the livestock industry, much of it has had to be used because of increasing scarcity and lower value of range forage, manifest in longer winter feeding periods and increased need for supplements at other times.

Numerous examples might be cited from all sections of the West of longer winter feeding periods because of scarcity of range feed. Cattle are now fed hay and other roughages often for 3 to 5 months, whereas in the early days such feeds were seldom required for more than a month or so and that commonly as a supplement to winter grazing.

Similarly the loss of highly palatable forage plants from the range and the necessity of livestock subsisting on low-value plants has required use of concentrates to furnish the protein and vitamin A (*69*) so essential to the well-being of the animals. Thousands of tons of cottonseed cake, for example, are fed on southwestern ranges and many carloads of grain and other concentrates are hauled to ranges in other parts of the West to supplement the low-quality range feed now generally available. The use of this supplemental feed, however, has made it possible to carry large numbers of livestock on ranges where they subsist primarily on the low-value plants and thus overgraze the more palatable.

Table 27 presents the approximate number of livestock, expressed in animal units per year grazed on range lands, including unirrigated farm pastures and stubble fields, and the approximate number which obtained feed from harvested crops, concentrates, and other supplements,[33] and from irrigated pastures[34] from 1870 to 1935. It is believed that the improved unirrigated farm pastures, grain stubble, and unrecorded concentrates shipped into the range area will offset the 11 percent decline in range area which has occurred, chiefly since 1890.

TABLE 27.—*Animal units dependent on range feed and on supplemental feed and irrigated pastures, in the 11 far-western States and the 6 Plains States, 1870–1935*

[In thousands of animal units]

Region and type of feed	1870	1880	1890	1900	1910	1920	1930	1935
11 far-western States:								
On range [1]	4,230	9,214	12,826	11,456	10,449	11,139	10,899	10,652
On other feed [2]	204	562	1,670	3,269	7,091	9,274	7,361	7,845
Total	4,433	9,776	14,496	14,725	17,540	20,454	17,960	17,577
Range portion of 6 Plains States:								
On range [1]	1,389	3,207	6,726	6,824	7,520	9,541	9,283	7,330
On other feed [2]	45	150	670	782	1,631	2,541	2,414	2,985
Total	1,435	3,357	7,135	8,206	9,151	12,082	11,707	10,315
Total range area:								
On range [1]	5,619	12,421	19,552	18,280	17,970	20,721	19,682	17,982
On other feed [2]	249	712	2,341	4,191	8,812	11,815	9,775	10,830
Total	5,868	13,133	21,893	24,471	26,691	32,536	29,457	27,373

[1] Including improved unirrigated farm pastures.
[2] Harvested crops, concentrates, and irrigated pastures.

[33] The approximate number which obtained feed from harvested crops and other concentrates was derived for each census year by relating the number of livestock obtaining feed from harvested crops and concentrates in 1928, as worked out by the committee of the U. S. Department of Agriculture (Feed Resources: 11 Western States. Ext. Ser. Circ. 41, 23 pp., illus., 1927, mimeographed), to the census record of hay and forage crop production in 1928, and then using that same index in relation to hay and other forage production as shown by the census in the other census years. The average production of recent years was used in 1935 rather than the short feed production in 1934. In the main this method is comparable to considering approximately 2 tons of cottonseed products, 2½ tons of grain and other concentrates, or approximately 7 tons of hay and fodder per animal unit per year. Those figures are more conservative than are sometimes used in determining feed requirements in the range area.

[34] Two acres of irrigated pasture is considered necessary per animal unit per year.

DECLINING NUMBERS ON RANGE THROUGHOUT THE WEST INDICATE EXCESS

In the range portion of the Plains States, numbers on ranges reached an early peak of over 8.5 million animal units about 1900. After a decline of around 10 percent to 1910 a new peak was established about 1920 when approximately 9.5 million animal units were on these range lands. Since 1920 there has been a decline of about 24 percent, especially marked in 1934. These figures may not be an entirely true picture of range stocking in the Plains States because of a number of uncertain factors. There are, for example, large quantities of unrecorded grain and other feeds shipped into this area, an unestimated area of grain fields that are grazed in winter and as stubble, and some of the cattle recorded as on farms and ranges on January 1 are shipped out of the area in the spring. The difficulty of taking adequate account of these features in the Plains States tends to show larger numbers of livestock on ranges throughout the year than is probably the case.

In the 11 far-western States the peak of livestock on ranges was reached about 1890, when 12.5 million animal units were obtaining their feed from range lands, 88 percent of the livestock then in these States. By 1910, around 10.4 million animal units were on range, about 60 percent of the total animal units. Following another rise to 1920 there has been a declining trend to 1935 when about 10 million, 57 percent of the total animal units, were on range lands. Thus a net decline of about 20 percent has occurred on range lands since 1890.

Figure 53 brings out the decline which occurred in the stocking of range lands between 1890 and 1910, and again between 1920 and 1935. While the grazing of heavier animals, as a result of better breeding and other improved animal production practices, may account in part for these declines, they are also undoubtedly due partly to a declining range-feed supply caused by overstocking.

The rise from 1910 to 1920 represents primarily the increase caused by war demands and does not indicate that there was range forage available for the excess livestock. In fact there are many indications that excessive stocking became the rule. In western Texas, for example, the upward trend was abruptly halted in 1916 and 1917 when range conditions failed, starvation losses were widespread, and forced shipments of livestock were made as ranges became more depleted. Along the Texas & Pacific Railroad in the Trans-Pecos country, ranges presented a pitiful sight. Feed gone, carcasses of cattle in great numbers around water holes, and gaunt, stary-eyed cattle still alive, their ribs all but protruding through the flesh—all these evidences told a tragic story of failure to keep numbers within safe limits of range-feed production.

The opening up of new areas by water developments, trails, and other means, has also been a factor in holding up livestock numbers grazing range lands. At first the more readily accessible ranges were stocked. As high prices stimulated expansion or as exhausted feed supplies, especially during drought, compelled removal of livestock from overgrazed ranges, stockmen have drilled wells, constructed reservoirs, and made other improvements in order to utilize formerly unused or lightly used ranges. Such improvements expanded the range livestock industry to the point of compensating

for livestock decreases necessary on many overstocked and deteriorating ranges.

Even the decline from 1890 to 1935 does not in itself indicate that range feed would satisfactorily support the reduced numbers now grazing on ranges. Many herds are being carried on little more than a subsistence basis, aided by the feeding of concentrates. Under such conditions of excessive stocking, cattle, sheep, and especially goats, have continued to graze ranges after all palatable feed had been consumed. It has been necessary for the livestock to subsist almost entirely upon low-value plants such as the common sagebrush,

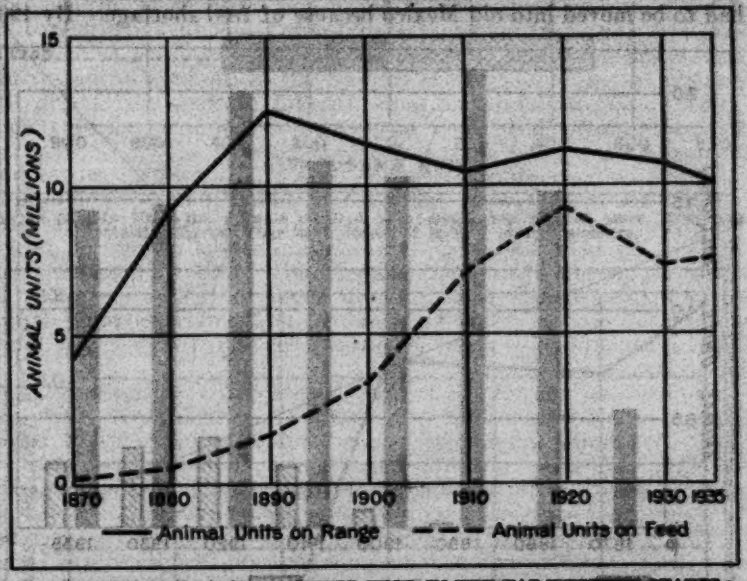


FIGURE 53.—RANGE VERSUS OTHER FEED IN THE FAR-WESTERN STATES.

Despite rapid stocking of range lands between 1870 and 1890, the declining trends in animal units on range from 1890 to 1910 and 1920 to 1935, indicate at least in part depletion of range due to overstocking. This indication is substantiated by the increasing use of expensive supplemental feed.

yellow brush, and weeds, which under conservative utilization would be grazed, but little except possibly in dry years.

The striking increase in livestock carried on feeds other than range forage shown in figure 53 is in itself an evidence of overstocking. Stockmen do not feed hay, costing $5 to $20 or more a ton, or costly concentrates, if adequate range pasturage worth $1 to $3 and often less for an equal feeding period is available. Winter feeding is expensive and ranchers are now compelled to rely largely on the cheap summer forage for profit.

VARIATION IN THE INDIVIDUAL STATES

The situation in the 11 far-western States as a whole is duplicated to a degree in most of the individual States. New Mexico, for example, illustrates an even more marked decline in numbers of live-

stock with declining grazing capacity of range lands and increasing numbers on supplemental feed (fig. 54). In 1890 approximately 2.1 million animal units were grazing range lands, and according to historical and other evidences serious damage was being done to ranges at that time. Both in 1900 and 1910 there were approximately 1.6 million animal units on the range. It is possible that with these lower numbers there were favorable years when the ranges of the State as a whole were not materially overstocked. But, by 1920, war demands had again increased numbers on ranges to more than 2 million animal units and the evidence is ample that ranges throughout the State were then seriously overstocked. In 1924 many cattle had to be moved into old Mexico because of feed shortage. By 1930

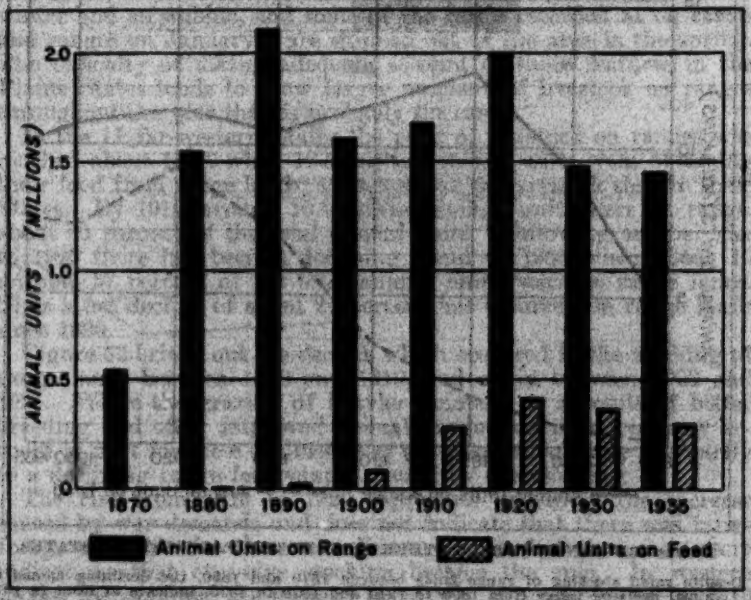


FIGURE 54.—In New Mexico, a State in which livestock depend principally upon range, a decided downward trend in range forage supply since 1890 is indicated.

numbers on ranges had dropped to about 1.5 million animal units, a decline of about 25 percent in 10 years and approximately this same number is grazing range lands in 1935.

In Utah, too, there has been a declining tendency in numbers of livestock grazing range lands since 1900. The increases as a result of war demand were not so great as in New Mexico and some other States. Increased feed has been an important factor in maintaining livestock in the State as a whole. In all, range lands and unirrigated pastures were furnishing only about 45 percent of the feed for livestock in 1935, in contrast to about 77 percent in 1900, as shown in figure 55.

In contrast to declining trends in most other range areas where depletion has resulted from overgrazing, the 33 counties in the range

portion of western Nebraska have carried increasing numbers of livestock on range up through 1930 (fig. 56). These counties are made up primarily of the sand-hill tall-grass prairie type and native hay meadows, which up to 1934 showed little if any deteriora-

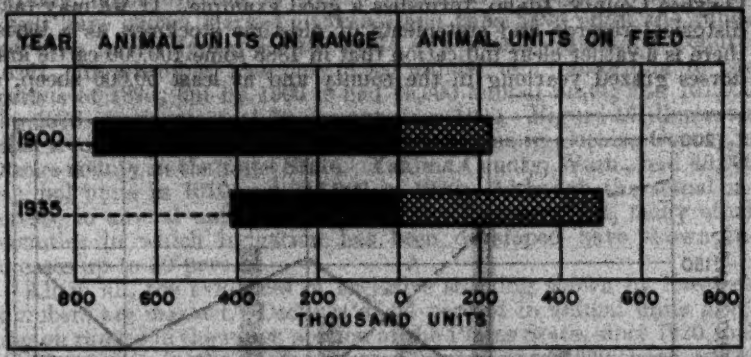


FIGURE 55.—In Utah the animals on feed have more than doubled since 1900, and animal units on range have decreased in still greater numbers.

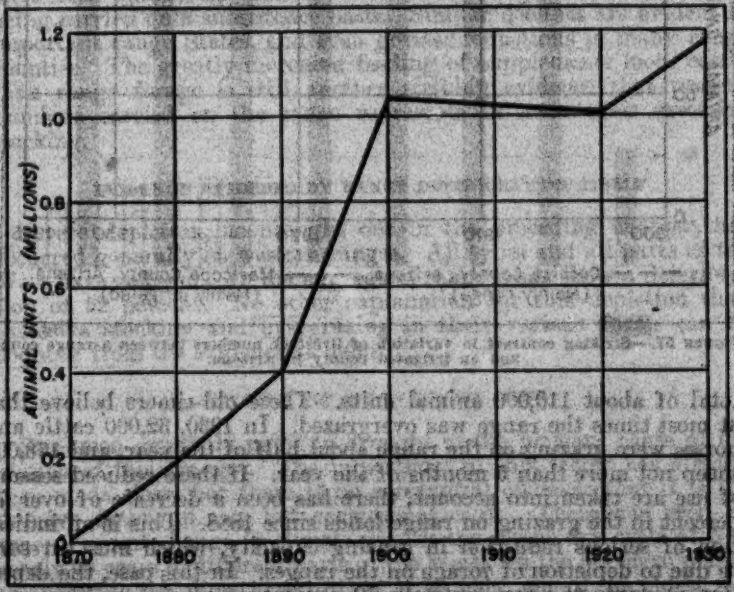


FIGURE 56.—Livestock obtaining feed from range lands in western Nebraska show an upward trend; care of the range on approximately 12,000,000 acres of sand-hill country, which constitutes the bulk of the range in this State, has made this possible.

tion in forage production. In the sand-hill area, in fact, there appears to have been an improvement in forage conditions during the last 50 years as a result of control of prairie fires and conservative grazing.

RANGE COUNTIES SHOW MARKED DECLINE

When one considers numbers of livestock within most of the counties primarily made up of range land, the effect of overstocking in causing decline in numbers over the years becomes quite marked. Owyhee County, Idaho, furnishes a good example. If we may take historical records and statements of old-time stockmen as a basis, there is a rather clear indication that in 1888 some 100,000 cattle and horses grazed yearlong in the county and at least 50,000 sheep, a

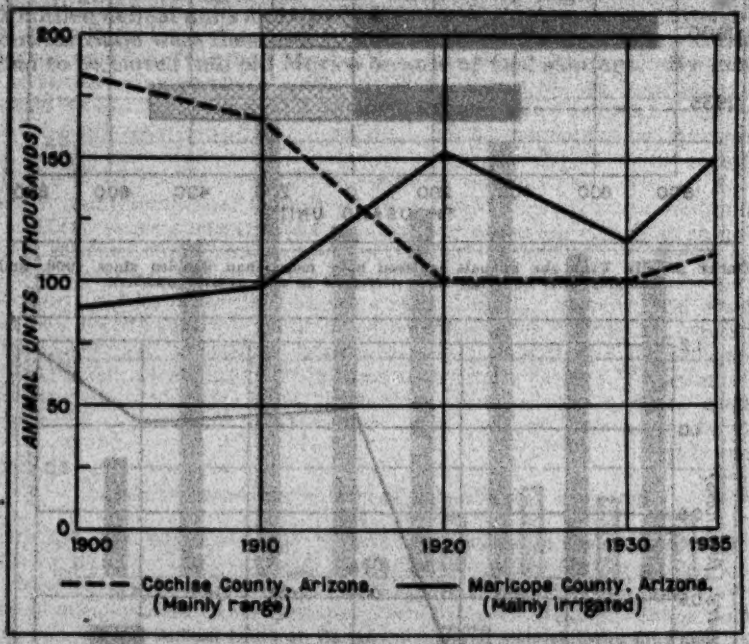


FIGURE 57.—Striking contrast in variation of livestock numbers between a range county and an irrigated county in Arizona.

total of about 110,000 animal units. These old-timers believe that at most times the range was overgrazed. In 1930, 32,000 cattle and horses were grazing on the range about half of the year, and 178,000 sheep not more than 5 months of the year. If these reduced seasons of use are taken into account, there has been a decrease of over 70 percent in the grazing on range lands since 1888. This is an indication of serious reduction in grazing capacity, which must in turn be due to depletion of forage on the ranges. In this case, the depletion amounts to approximately 70 percent of virgin conditions, as shown by an intensive plot survey of the county by the Forest Service in 1932.

Many other range counties throughout the West show materially lower numbers of livestock because of overstocking, although supplemental feed has, in part, offset the decline in range feed. For example, numbers of livestock expressed in animal units in Malheur County, just across the Oregon line from Owyhee County, Idaho,

have declined, according to the census, about 30 percent between 1900 and 1930; and in Rio Arriba, Socorro, and Sierra Counties, N. Mex., 60, 68, and 52 percent, respectively.

While numbers of livestock in most range counties have been declining, other counties in which considerable irrigation has developed have shown marked increases and thus have offset the range counties in the figures for the State as a whole. Maricopa County, Ariz., for example, had only 8,000 animal units according to the census of 1890; but by 1900 it had 89,000 animal units; and 151,000 by 1935—an increase of 70 percent since 1900. Figure 57 illustrates this trend in contrast to the 29 percent decline in Cochise County, a range county in the same State. Yakima County, Wash., had 46,000 animal units in 1910 and 114,000 in 1930. Although the actual increase in animal units has not generally been so great, many other counties in which irrigation has been developed have shown increases up to 50 percent.

All in all, the evidences of excessive stocking shown by livestock numbers are marked. Declines of 24 percent in animal units grazing on ranges in the range portion of the Plains States since 1920, and of 20 percent in the 11 far-western States since 1890, have added importance when it is considered that many areas of poor accessibility have been opened up since 1890 and most range livestock are now being carried on a subsistence basis. Similar declines are evident in important range States, and even greater reductions in many range counties. The greatly increased feeding of supplements more costly than range forage is still another striking evidence that present numbers carried on the range represents in most cases excessive stocking.

EVIDENCE AFFORDED BY RANGE DETERIORATION ITSELF

Severe depletion, as brought out in the preceding chapter, has occurred generally on western ranges. All types and all parts of the West have suffered. In the aggregate, range lands show a deterioration of 52 percent. No other explanation for this depletion than excessive stocking and overgrazing in their various forms can be deduced from the evidence at hand.

DEPLETION NOT DUE TO CLIMATE ALONE

Stockmen generally point to drought as the primary cause of depletion of their ranges. The importance of this factor has already been made clear, but there is no substantial evidence that it is the decisive factor in any but exceptional cases. There has been no general recent change in climate despite the recent dry cycle of 5 to nearly 20 years in different parts of the West. In the northern plains, according to the climatic records at Miles City, one of the oldest stations, the recent dry cycle is no worse than the dry period of the eighties nor as long.

Specific evidence that climate alone is not responsible for depletion appears in the comparable quadrat records of conservatively grazed and ungrazed plots on semidesert ranges of southern New Mexico (*95*). Conservatively grazed areas varied with rainfall almost di-

rectly, as did ungrazed comparable plots. On the other hand, range areas excessively stocked deteriorated more rapidly, recovered more slowly, and consistently supported a poorer stand of forage.

Fenced and conservatively used areas throughout the West are invariably better than excessively stocked and therefore heavily grazed ranges. But drought does not stop at fence lines.

REASONABLE GRAZING NOT DETRIMENTAL

Investigations have shown that a reasonable degree of cropping is not detrimental to plant growth. Studies (*116*) in the mountains of central Utah indicate that "grazing closely twice or even three times in a (summer) season, provided the first grazing is late enough and the intervals are sufficient for the vegetation quite to recover from each cropping, ordinarily does not seriously affect the yield and vigor of the plant cover."

The sand hills of Nebraska already cited are an example of a large area under private ownership, about 12 million acres, where the vegetation has been maintained or improved in recent years under grazing. There, slight deterioration of the vegetative cover is so apt to start blowing of sand that damage can be readily recognized. Rainfall is sufficient, and the character of the vegetation is such that when the cause of damage is overcome a rather rapid recovery is made.

Under regulation of grazing on the national forests an effort has been made to adjust numbers of livestock to the sustained grazing capacity of the range forage. While there is still more or less depletion of ranges from their virgin conditions prevailing within national forests, and while adjustments in recent dry years have not entirely kept pace with depletion, most of the national forest ranges under grazing use have shown improvement in forage conditions since they were placed under administration by the Department of Agriculture.

Even on semidesert grass and shrub ranges of the Jornada Experimental Range in southern New Mexico, where vegetative conditions vary widely from year to year, studies (*93*) show that, on sandy soils—

> * * * the average density of black grama over the 13-year period (1915 to 1927) was practically the same under conservative grazing as under no grazing. The decline during drought was rather similar under both conditions, but the return of favorable rainfall brought more rapid recovery under conservative grazing. Conservative grazing appears to break up the large, separated tufts formed under freedom from use into smaller tufts better adapted to make efficient use of the available soil moisture. * * *. black grama remains dominant after drought in spite of the rapid increase of associated grass and weed species.

A somewhat similar improvement and maintenance of tobosa grass areas on clay soils was noted within the Southern desert shrub type (*30*).

PLANT INDICATORS OF OVERBREAKING

A plant is, in effect, a plant-food factory. It does not draw its food already manufactured from the soil. It must take up water and essential plant-food elements from the soil via the root system and transport them to the leaves where, together with carbon dioxide taken in through the leaves from the air, it manufactures the ma-

terials which make possible its further growth, the development of seeds, and—of particular importance in range management—the storage of food for winter maintenance and the beginning of herbage growth the following spring. If the leaves which form this manufacturing plant are consumed before sufficient foods have been formed to take care of the essential growth functions, the plant's vigor will be sapped. If the food supply is inadequate, the plant may succumb. It is of vital importance, therefore, to have a substantial leafage available on plants during the growing season.

In the semiarid range country of the West there is naturally a critical balance between the moisture available for growth and the needs of the plant cover, with a resulting competition for moisture. Where grazing is introduced and the range is overstocked, the palatable plants are grazed first and most heavily and are naturally the ones to suffer most in this intense competition. The inevitable thinning of the palatable plants releases the secondary species and gives them the opportunity to increase in density. Where they in turn are heavily grazed, in the absence of the more palatable plants, opportunity is given for still less palatable species to gain dominance.

Overgrazing for an extended period will thus leave "earmarks" which can usually be recognized (*79*), especially in the scarcity of the choicest range plants and the predominance of low-value annual weeds and grasses, or other plants which have little or no value for grazing. Along with these signs will be others equally obvious, the presence of dead and partly dead stumps or stubby branches of shrubs, noticeable damage to tree reproduction, and erosion and barrenness of the soil, usually accompanied by a series of stock trails terracing the slopes.

To recognize current overgrazing is more difficult, yet it is important in order to make timely adjustment. It is seldom that all species are of equal palatability on a range. Since it is the important palatable plants which furnish the bulk of the feed, it is essential to use them as helpful criteria, to observe closely the degree to which they are grazed, and to stock on a basis that will not injure them. Many palatable grasses on western ranges can only sustain their vigor and density under a degree of grazing which will utilize by the end of the season no more than 70 to 80 percent of their herbage production. Of sod-forming grasses, such as most gramas, and on soils that are moderately compact, a slightly higher percentage of herbage may be taken in years of favorable rainfall. With some bunchgrasses, however, and on sandy soils, it may not be wise to utilize even 70 percent of the palatable herbage. Palatable shrubs can seldom maintain their vigor when more than 75 to 80 percent of the tender twigs and leafage is grazed. Still, on most ranges, and especially on those inadequately regulated, palatable plants are being grazed more closely than these percentages even in favorable years when maximum herbage is produced on each plant.

On nearly all ranges many plants of moderate and low palatability are present, which give the appearance of considerable "feed" when those that are more palatable have been utilized as fully as they can withstand. Dominance of secondary species prevails on millions of acres of ranges depleted in excess of 50 percent, and even on some

showing a 25- to 50-percent depletion. On some of the more seriously deteriorated ranges these secondary species have been replaced and only low-value or worthless plants remain. Such is the condition of many of the ranges depleted in excess of 75 percent. In the light of such evidence, can there be doubt that excessive stocking with its inevitable overgrazing has been an important factor in range depletion?

EVIDENCE AFFORDED BY PRESENT STOCKING AND ESTIMATED GRAZING CAPACITY

Table 28 shows the approximate present stocking and estimated grazing capacity of range lands by ownership jurisdictions. The figures on present stocking on the national forests and Indian lands are from actual records. Those for other jurisdictions have been approximated from the best available information. The estimates of grazing capacity are based upon field surveys of recent years and careful examination of some 20,000 vegetation plots representative of all range types and ownerships.

These data show that, even after the removal of large numbers of livestock in 1934, there were still on January 1, 1935, approximately 17.3 million animal units on ranges within the range territory, of which approximately 10 million were on ranges in the 11 far-western States. In every ownership class more livestock are now grazing range lands than the estimated grazing capacity would indicate could be supported on a sustained basis year after year. They also indicate, considering the quality of the range, a much heavier stocking on public domain (including grazing districts) and on State ranges than on national forests.

TABLE 28.—*Present stocking (Jan. 1, 1935), estimated grazing capacity, and degree of excess stocking on usable western range*

Region and ownership jurisdiction	Present stocking	Present estimated grazing capacity	Degree of overstocking[1]
	1,000 animal-unit years	*1,000 animal-unit years*	*Percent*
11 far-western States:			
National forests	[illegible]	[illegible]	7.1
Other Federal	1,[illegible]	1,[illegible]	77.1
Indian lands	[illegible]	[illegible]	56.5
State, county, municipal	[illegible]	[illegible]	73.4
Private	4,[illegible]	4,270	56.1
Total	10,[illegible]	7,134	43.6
Range portion (6 Plains States):			
National forests	[illegible]	[illegible]	
Other Federal	[illegible]	[illegible]	34.6
Indian lands	[illegible]	[illegible]	45.1
State, county, municipal	1,[illegible]	[illegible]	138.5
Private	5,[illegible]	3,[illegible]	63.6
Total	7,[illegible]	5,[illegible]	44.2
Total range area:			
National forests	1,[illegible]	[illegible]	7.9
Other Federal	1,[illegible]	1,[illegible]	76.5
Indian lands	[illegible]	[illegible]	55.9
State, county, municipal	1,[illegible]	[illegible]	89.8
Private	11,[illegible]	7,[illegible]	60.4
Total	17,[illegible]	12,[illegible]	42.6

[1] Excess over present estimated grazing capacity.

As previously indicated, the present stocking of ranges in the Plains States may indicate heavier overstocking than actually prevails because of the unknown quantity of concentrates shipped into the area, the grain fields which are grazed in winter or as stubble, and the heavy movements of cattle out of the area in the spring—this last factor affecting especially State and private lands in Texas.

It will be noted that the degree of excess stocking amounts to about 7 percent on national forests. This is the lowest of all and reflects the efforts of the Forest Service to keep grazing within proper limits. The greater part of this overstocking on national forests is the result of deterioration from drought and the heavy demand from permittees to maintain their herds during that period when their own ranges were extremely short of feed. During the drought of 1934, for example, larger numbers of livestock were carried on national forests than normally and for a longer season.

Although overstocking shows up more seriously because of the combined deterioration from drought and overgrazing, especially in the Plains States, it indicates a very serious situation in all parts of the West. This is especially true of the public domain, part of which is being placed under administration in grazing districts, where it will require a 43-percent reduction in number of livestock now grazed to overcome the 77 percent overstocking which prevails. Average excess stocking of about 60 and 100 percent on private and State lands, respectively, indicates the serious situation prevailing on these ownerships and helps to explain the severe deterioration in grazing capacity already discussed in an earlier chapter.

EVIDENCE AFFORDED BY SERIOUS LOSSES AND UNSATISFACTORY PRODUCTION

When more livestock are on a range than the available forage crop will support, it is obvious that a shortage of palatable range feed—at least toward the end of the grazing season—with consequent starvation will result.

On ranges on which the palatable plants, such as perennial grasses, have been replaced largely by such low-value plants as common sagebrush, greasewood, and rabbitbrush, grazing of approximately the numbers formerly placed on the range now results in the livestock subsisting almost entirely on low-value plants. Stockmen and representatives of the Bureau of Animal Industry report increasing losses among sheep on the winter, or so-called "desert" ranges of western Utah, primarily from malnutrition. This is not surprising in view of the fact that the forage value of these ranges is now only 56 percent of that of comparable areas in good condition, as shown by a survey of the situation made by the Forest Service in 1932.

Poor or emaciated condition of livestock frequently contributed to losses from other causes. Animals in a weakened condition are naturally less resistant to many diseases, there is greater danger of loss from predatory animals, and weak cows are commonly lost in boggy places. The mortality from poisonous plants is also invariably heaviest when livestock are hungry or when the range is closely grazed.

Official estimates of the Department of Agriculture record annual death losses of 9 percent or more among grown sheep as a rather

common occurrence in the principal range States, even in years that were not particularly dry. Since these estimates include losses on farms, where the average loss is lower, there is little doubt but that range losses are even more severe than the State averages. Furthermore, range losses are greatly reduced by supplemental feed. Under conservative grazing and good range conditions, with adequate supplemental feed for emergencies, losses are usually not in excess of 5 percent and sometimes are lower.

Losses among range cattle are also two or three times as high on most unmanaged range areas as they are on conservatively grazed ranges in good condition. With average annual losses of about 7 percent among cattle in the range States in many years, there can be little question that inadequate feed from overstocking is a potent factor.

In drought periods, especially in the Southwest, and during severe winters on northern ranges, losses of livestock in a weakened condition from a range-feed shortage on overstocked ranges often become appalling. From 25 to 35 percent of some herds are lost in such so-called "die-offs." On the other hand, herds on lightly or moderately stocked ranges weather such adverse conditions with losses but little greater than their average, usually not exceeding 3 or 4 percent.

Low calf and lamb crops are but another evidence of excessive stocking. Cows and ewes in a weakened condition from feed shortage or other malnutrition often fail to breed during the year, and calf and lamb crops on western ranges accordingly are lower than is desirable. Official estimates of the Bureau of Agricultural Economics, for example, show that in New Mexico, for the 11-year period from 1925 to 1935, the average lamb crop amounted to only 62 percent, reflecting, at least in part, a scarcity of feed on the ranges in most years. In 1926, following a year of fairly good rainfall and low numbers of sheep in the State, the lamb crop amounted to 78 percent. In 1932 and 1933, with about a third again as many sheep and following average or better years of rainfall, the lamb crops were only 52 and 50 percent, respectively. This would indicate that there is some relationship between low lamb crops, excessive stocking, and poor feed.

In southern Arizona the calf crop of representative cattle outfits using unregulated, heavily grazed ranges averaged only 55 percent [15] for the 8-year period 1916 to 1923, inclusive. Since average annual losses amounted to more than 10 percent, net production was only 45 calves for each 100 breeding cows, inadequate for profit. This is in contrast to an average calf crop of 72.6 percent for the same period, on the comparable but more conservatively grazed range, in good forage condition, within the Santa Rita Experimental Range. Here losses from all causes amounted to 3.2 percent and net production was 69 calves for each 100 breeding cows, or more than half again as many as on the depleted, overstocked range.

On heavily stocked semidesert ranges in the Southwest (*50*), and on brush ranges of southwestern Utah (*53*), many cows calve only every other year. Under such conditions calves grow out poorly and require an extra year to attain a weight comparable to calves from better and more conservatively grazed ranges.

[15] United States Department of Agriculture, Forest Service. Field Day Program, Santa Rita Range Reserve. 20 p., illus. 1933. [Mimeographed.]

Even on good short-grass plains range of eastern Montana, lower calf crops and poor development of calves are clear indications of overstocking. Sixty young cows have been grazed for over 3 years on experimental range pastures at the United States Range Livestock Experiment Station near Miles City, Mont., under the supervision of the Forest Service in cooperation with the Bureau of Animal Industry. All ranges were in good condition at the start. Twenty of these cows have grazed 23 acres per cow per year, and this is considered to be approximately a 25-percent overstocking. Their average calf crop for the 3-year period 1933 to 1935, inclusive, has been 70.0 percent, in contrast to 81.7 percent from the 40 cows on more conservatively grazed pastures. Net calf production in pounds per cow has been 194.5 pounds for the 23-acre-per-head group and 264.3 for the groups on more conservatively grazed range—a severe penalty for such overstocking, even though range depletion in this instance was very slight until the 1934 drought.

A slight loss in weight of the cows, such as prevailed on the overstocked range pastures, and even the lower calf weights, are often not recognized by stockmen. Furthermore, on some ranges secondary species, while not as palatable, may be almost as nutritious as the more palatable species. Accordingly, slight deterioration of range may not be sufficiently reflected in the condition of the livestock for stockmen to realize the injury that overstocking is doing to the range and through it to their own ultimate well-being.

Such increase, if any, as has occurred in meat and wool production in the Western States has been principally due to changes in class and age of livestock, improved breeding, increased feeding, and other production factors, rather than because of maintenance or improvement of range feed. During the latter part of the nineteenth century, 4- and 5-year-old steers were commonly shipped, grass-fat, from ranges; at present, breeding cows predominate on the range. Calves are often sold in the fall or yearlings are marketed in spring or fall, especially in the Southwest. In other places many steers are held over until they are 2 or 3 years of age. During the early years of the western sheep industry, wethers predominated on the range. Later, as the public taste for lamb increased and as wool prices fell, the wether herds gave way to those made up of breeding ewes from which fat or feeder lambs are marketed. Furthermore, there has been a marked improvement, especially in the last 20 years, in the grade and type of animals grazed. Scrub bulls and rams have practically disappeared from the range country, being supplanted largely by purebreds or very high-grade sires. Herds are culled closely. The net result has been a greater production per animal. Wool production per animal has about doubled in the last 50 years.

On many range areas, however, much of the advantage to be gained from the improved breeding and other livestock management has been lost. To develop well, the better bred animals require adequate feed. In many years calves are stunted, lambs must be sold as low-grade feeders rather than as killers, and wool production is hampered by scant and uncertain range feed supplies. In drought years the situation often becomes acute; heavy starvation losses occur in the breeding herd and well-bred breeding cows are sacrificed at

forced sale. Usually the unfavorable range conditions are not so severe on sheep, although herds have been decimated by feed shortage from drought and severe winters. Thus, years of careful breeding may be lost in a single year because of range feed shortage from excessive stocking and range depletion.

Causes of Excessive Stocking

The causes of excessive stocking include: Competition for the use of range lands; the stockman's belief that profits result from maximum numbers grazed; permitting ranges to suffer in the attempt to reduce expenses; stocking on the basis of better years; restocking too soon after drought; pressure to graze maximum numbers on public ranges; the failure of certain public agencies to face their conservation responsibility; and finally, a lack of realization of the consequences.

Competition for Range

On unregulated public domain and the intermingled uncontrolled private and State land, the possession of the range has been largely dependent upon such heavy use that even though a stockman might desire to reserve range forage for contingencies, to do so would simply invite others to come in. Accordingly, the resident stockman has stocked his range excessively to keep the forage reasonably well grazed as it grew. Since many small tracts of private- and State-owned land are intermixed with unregulated public domain, the unrestricted use which has prevailed on the 149 million acres of usable range on the public domain has affected probably 150 million acres in addition. Even with the establishing of 80 million acres of grazing districts under the Grazing Act, doubtless more than 100 million acres of intermingled ownerships will still be open to grazing use by all comers and will continue to be excessively stocked until provision is made for its management.

Stockmen Believe Profits Depend on Numbers

Stockmen primarily concerned with making ends meet or in making a profit, to which they are justly entitled, generally believe, even in the face of periodic financial difficulties, that the greatest financial return results from grazing the maximum number of livestock on the range. When high prices prevail they sometimes hold surplus breeding stock on already crowded ranges in an effort to increase production. On the other hand, when prices are low they often attempt to carry over salable animals for a higher market, with inevitable overstocking of the range. Loans usually have been negotiated on livestock numbers almost regardless of costs, ability of the range to support the number grazed, or net production. In some instances loaning agencies have unwittingly encouraged overstocking when prices have declined by requesting stockmen to retain young salable breeding stock in order to reduce the per head value of the loan. By so doing they have overstocked and often undermined the range forage resource which, in the last analysis, supports the loan.

PERMITTING RANGES TO SUFFER TO REDUCE EXPENSES

Ranges are permitted to suffer in the attempt to reduce expenses. The relatively high cost of supplemental feed, especially on areas where it is not abundant, leads to turning livestock on ranges before forage plants have attained sufficient growth to prevent injury. Similarly it leads owners to leave stock on the range so late in the fall and winter that trampling may do severe damage to saturated soil. Such practices are common throughout the West. In Utah and Idaho they have seriously impaired the grazing value of millions of acres of spring-fall range.

STOCKING ON BASIS OF BETTER YEARS

In years of good rainfall and favorable climate, the forage on the range makes a good growth and livestock do well as long as abundant feed lasts. This naturally encourages users to make the most of the available feed and inevitably leads to excessive stocking when forage production drops in dry years. In view of the deterioration which such heavy stocking in dry years brings about, as has already been discussed in connection with the effects of climatic variations, it would seem that the fallacy of stocking ranges on the basis of feed production in good years would be evident and that definite provision would be made for leaving a substantial margin of range feed in the average or better year. Still, many users stock on the basis of the better years, hope for rain, and, when the range deteriorates from overstocking and average rainfall consequently fails to produce the forage they expect, believe they are in a drought period.

RESTOCKING TOO SOON AFTER DROUGHT

Climatic changes have a way of playing tricks with the vegetation that are sometimes deceptive. As pointed out in the discussion of climate, the stand of perennial grasses is less dense in the year following a drought than during the drought year itself. When unusually favorable rainfall follows a drought year, as is sometimes the case, the reduced stand of vegetation makes an exceptional height growth and appears to be abundant. This often leads to prompt restocking. Too many livestock at that time may so closely utilize the forage as to seriously affect recovery from the drought.

PRESSURE ON PUBLIC RANGE OFFICIALS

On publicly regulated range such as on the national forests, many permittees exert constant pressure to be allowed larger numbers than they are now permitted. Some challenge reductions necessary to control overgrazing, even when they realize that the ranges are suffering from overuse. The hope always exists that climatic conditions will bring better feed the following year. This desire to prevent reduction in livestock numbers regardless of overstocking has even crept into the provisions of the Grazing Act.

SOME AGENCIES HAVE NOT FACED THEIR CONSERVATION RESPONSIBILITY

Grazing leases of State lands and on certain Federal reservations have been made without adequate thought for perpetuation of the resource. Ordinarily, there has been lack of knowledge of actual conditions on the range and either inadequate or complete absence of inspection of actual use and management of the lands administered. The net result has generally been the grazing of more livestock than the range could support on a sustained basis.

Many leases of such lands provide for the continued grazing of the number then grazing on the range or for the average number which have grazed over a period of years. Such stocking is often spoken of as grazing capacity and is sometimes used without field check of range conditions as a basis for proposed adjustments. If range forage has been adequately maintained, average numbers grazed furnish an excellent criterion. If, however, through overstocking, the value of the range has greatly declined, there can be no assurance that the range will continue to carry the number previously grazed. In fact, continued grazing of the same number will simply accentuate the degree of overstocking and intensify range deterioration. Often under such conditions a drastic reduction in livestock of one-fourth, one-half, or even three-fourths may be necessary to check further deterioration and start recovery.

LACK OF REALIZATION OF CONSEQUENCES

Stockmen are apt to overestimate the grazing capacity of their owned, leased, or publicly controlled land because of lack of knowledge of what the range will support on a sustained basis or because of a failure to take into consideration all of the factors involved. There is a lack of adequate knowledge of just what grazing capacity is and of simple measures to determine it. This is a fertile field for research.

The public also fails, generally, to recognize the serious consequences of overstocking to the livestock industry and to community welfare, or to take prompt action after recognition. Here in the United States the whole social system has been built upon individual initiative and action, a vital factor in development but an encouragement to destructive exploitation. For years the unreserved public domain has been a grazing common. Now and then the injured public, on their own volition, took action to correct some particularly bad situation, such as the closing of the Manti Canyon watershed to sheep grazing about 1900 after disastrous floods had caused great damage in the town of Manti (*108*). The establishment of the national forests came in an effort to protect forests and mountain watersheds in the public interest. Many additions of range lands have also been made to national forests at the request of users or the interested public to protect more adequately the resource values for community benefit. However, even though conditions on the majority of range lands have continued to affect community welfare seriously, the interested public has hesitated to take action.

Overcoming Excessive Stocking Not Insurmountable

With several hundred million acres excessively stocked and seriously depleted, the stemming of potential range destruction may seem like a hopeless task. Although the situation was rather critical in 1934, during that year the drought, depressed prices, and purchases by the Federal Government of drought-stricken livestock greatly reduced livestock population. However, numbers of livestock increased during 1935 on many ranges. True, shipments from ranges and starvation losses have been so large that conservative increases can be made in limited localities within the next few years after the ranges recover from their present impaired productivity. In most cases, however, the break-down of ranges from past overstocking and the recent drought is so great that livestock on range lands still exceed the grazing capacity by approximately 62 percent and will have to be reduced by 38 percent in order to overcome the overstocking. Ways and means of developing an understanding of the proper basis for stocking to sustain production of forage and livestock, a willingness on the part of users to adjust stocking to safeguard against impairing production, and regulation of public ranges which will protect them against abuse are features which will need consideration in order to overcome excessive stocking now prevailing.

RULE-OF-THUMB MANAGEMENT

By M. W. Talbot, Senior Forest Ecologist, California Forest and Range Experiment Station

As the frontier retreated westward into a land of no fences and few familiar kinds of forage, the wide expanses of inviting range brought both rich opportunities and a host of knotty problems. As great numbers of cows and sheep pressed upon the heels of the vanishing buffalo and swarmed over the free-grass country, a unique brand of thought and attitude evolved. This western range philosophy was quite logically the outcome of the challenge of a strange environment to the sturdy pioneer stockman and of his attempts to adapt his growing needs to the strange conditions.

The early stockman had to develop a whole new system of range husbandry. In the absence of adequate experience or research facts, management of the grazing resource developed largely—and quite naturally—from a basis of rule-of-thumb. Thus the term implies all the sundry kinds of range practices that had their beginning in the stern necessities of pioneer times and that, in varying degree, still persist. Many of these practices, backed by excellent judgment, have stood the test of years. Noteworthy are riding, roping, branding, etc.—the whole technique of handling livestock, in which high proficiency has been attained.

Many other practices, however, have led to range depletion and consequently have proved to be unsound from the standpoint of perpetuation of the range resource and its other public values. For these practices the stockman must share the blame. Still, in examining them for clues to their correction, one must recognize that the stockman has been in the grip of powerful economic forces to a varying but considerable degree. It was inevitable that many individuals confronted with the problem of making a living would be led into range practices that are, in the end, damaging to the land. Just how, then, have these defective practices operated?

Harmful Practices Evolved By Rule-of-Thumb

TOO MANY ANIMALS ON THE RANGE

Most range deterioration can be traced back to the attempt to graze more animals than the land can safely support from year to year. Drought, lack of knowledge of what the range will stand, the urge for greatest immediate profit, economic pressures, and other contributing factors have all played a part. But most of these have been expressed in terms of overstocking, which still looms as the most spectacularly destructive of rule-of-thumb practices. Because of its high importance as a major factor in depletion, the preceding section of this report has been devoted to a detailed discussion of its widespread occurrence, its various causes, and its destructive effects.

FAULTY DISTRIBUTION OF LIVESTOCK

Uniform grazing over all parts of the average western range unit is rarely obtainable because of variations in topography, timber or brush cover, kind of forage, location of watering places, and similar differences. Certain parts of a range are thus grazed more heavily than others; these are the critical spots or tension zones in which range damage has been most pronounced.

CONCENTRATION OF LIVESTOCK IN VALLEYS

Crowding of choice range is partially explained by the fact that most western ranges produce "pie" or "ice cream" forage, as well as "hardtack." Livestock prefer the lush forage of mountain meadows, for example, to the drier bunchgrass on surrounding timbered or brushy slopes. Moreover, cattle tend to drift to the more accessible, comparatively open, and usually better watered meadows, neglecting the outlying feed; and sheep are more easily herded in the open areas. Allotting livestock to ranges on the basis of the forage crop on their total acreage has thus quite obviously meant excessive numbers of animals on the comparatively small meadows, canyon bottoms, and other areas of choice feed. The inevitable results, overgrazing, reduced forage crop, increased erosion, and impaired watershed value, can be illustrated by two examples.

A spectacular illustration is the Canada de los Alamos, a privately owned meadow in the Santa Barbara National Forest, Calif. In 1880 a horse could step across the tiny creek meandering through this valley. Depletion of the vegetation carpet through continual overgrazing, combined with occasional rainstorms of great intensity, have brought about a striking change of scene—a great "barranca" (gully) 100 feet deep, 200 feet wide, and several miles long; an abandoned ranch house menaced by the encroaching arroyo; and permanent depletion of range values through lessened valley-floor water and volume of forage.

An historic stage stop on one of the early emigrant routes furnishes an even more convincing example of range destruction. Mountain Meadows, Utah, at the time of first settlement in 1862 was a fertile sod-bound valley of several thousand acres. A recent survey by the Intermountain Forest and Range Experiment Station reveals a striking contrast—as a result of man's occupancy, with his roads, ditches, and hungry herds, practically all of the deep-soil portion of the meadow has been worn and washed away, along with most of its original grazing capacity.

As the originally intact plant cover gave way on these and many other overgrazed areas, the most palatable forage plants disappeared and in their place inferior or worthless plants came in and grazing and watershed values dropped (fig. 58).

Equally serious is the "cracking under the strain" of small and inconspicuous mountain meadows ranging upward in size from 5 acres or less. Many of these in their primeval state were characterized by rivulets bordered by willows and grassy glades. Here, as in the big valleys, overgrazing was followed by thinning of sod, killing out of the willows, cutting of gullies, lowering of the water table, and drying of soil.

In appraising the significance of similar examples, which abound throughout the West, one who has reviewed the imposing array of evidence, locality by locality, states the conviction that serious range erosion in the Southwest followed close on the heels of excessive grazing by big herds on key areas (*22*). "The coincidence between the introduction of large numbers of stock and the cutting of arroyos indicates that overgrazing precipitated this form of destructive erosion" (*23*). And, in both the intermountain and southwestern regions, depletion and modification of plant cover incident to and following settlement and livestock ranching may be regarded as a probable cause of much subsequent erosion of valleys and mountain meadows, according to various geologists as well as foresters and

FIGURE 33.—GOOD RANGE PLANTS GO OUT WITH OVERGRAZING

Long-continued overstocking of the valley range on the right has resulted in the disappearance of the valuable saltbrush still abundant on the protected range across the fence, a thinning of sod, and an increase in small worthless shrubs. The net result is greatly reduced grazing capacity.

range technicians (*10, 51, 62*). The net result of overgrazing caused by poor distribution of stock has been the same, in varying degree, on thousands of valleys and mountain meadows throughout the West.

EXCESSIVE USE OF SHEEP BED GROUNDS AND CLOSE HERDING

Prohibited on the national-forest grazing grounds and the more closely supervised privately owned ranges, excessive use of sheep bed grounds and camps is still prevalent on unregulated portions of the public domain and on many private ranges, more particularly those of absentee owners, in spite of the fact that its evils have been quite apparent for over a third of a century (*38, 48*). The usual explanation is that the herding of sheep is somewhat easier from semipermanent camps, the use of which reduces the inconvenience of moving camp every 3 days, or oftener. Too frequently, therefore, the tendency has been to use the same camp for many nights

in succession, trailing the bands of sheep back and forth between the overused bed ground (adjacent to camp) and the outlying feed. In consequence, before the camp is finally moved, the bed ground and a needlessly large surrounding area has been severely trampled and grazed—in extreme cases even partially denuded, with the resultant loss not only of grazing capacity but also of much valuable topsoil from areas "grazed into the ground" year after year.

Much range damage also has been caused by closely massed herds of hurried jostling animals forced to graze in crowded compact bunches. With close herding feed is wasted through unavoidable trampling, and strain is increased on key portions of the range which usually are most in need of protection. To this extent close herding leads to the same evils as prolonged use of bed grounds.

Furthermore, unnecessary trailing by either sheep or cattle has caused great wear and tear on the soil-binding plant cover of swales and valleys. In little paths or trails the grass wears through to the soil. Down the deepening trails the water "first crept, then ran, and finally tore * * *" until great washes were formed—the gullies and arroyos which have seamed and scarred the western ranges in every direction.

INADEQUATE OR POORLY LOCATED WATERING PLACES

An insufficiency of stock waters, a condition found on much of the semiarid western grazing grounds (*15*), leads to excessive trampling about the water and increased trailing between water and feed (*136*). The destructive effect on the range is illustrated by conditions around a well in Millard County, Utah, on winter range where watering places were too far apart. Excessive numbers of sheep had been watered here for 8 years. Within a radius of 1,000 feet only 4.3 percent as much grass remains as on similar range 15,000 feet distant. Even within a 2,000-foot radius the forage has been reduced to about one-sixth of that on the more distant range, and the highly palatable plants have been obliterated.

As a result of depletion in its various aspects not only has the plant cover around this watering place been made much thinner and the soil exposed to wind and water erosion, but the vigorous invasion of low-quality forage plants on the desert subjects the valuable plants to such severe competition for moisture as to render the establishment of young plants difficult in the last extreme. Without reasonable reproduction it is only a matter of a few years until the best forage in this type becomes practically extinct (*136*).

POOR SALTING PRACTICES

The pounding of overgrazed spots is aggravated by obsolete salting practices, because salting only at the watering places, or in other places where stock are likely to "bunch up", nullifies any possibility of attracting cattle into areas of unused or lightly used forage. Experimental work, careful observations, and studies of existing practices of progressive stockmen on national forests and many private ranges have pointed out that salt is a "cheap cowboy." Systematic salting can be used to lessen undue bunching and overgrazing on areas where the animals tend to congregate (*32, 39, 79*).

To the degree to which no advantage has been taken of this progressive handling measure for effecting proper distribution of stock, inadequate salting practices have contributed their share to range depletion.

IMPROPER SEASON OF USE INJURES THE RANGE

Too early spring grazing on mountain ranges, another cause of local range depreciation, is an outgrowth of the insufficiency of spring range adjoining mountain communities, such as the Spanish-American settlements clustered around the base of the Sangre de Christo Mountains of northern New Mexico, and many others. In the early spring the stockmen, confronted with exhaustion of winter forage, with a limited ability to obtain more supplemental feed, and often the necessity to move stock off the home ranch stubble-fields and meadows in time for plowing and irrigating, have been insistent on turning stock into the high mountain areas as soon as the first green grass appeared in the wake of the receding snow banks. How to bridge this gap in the feed supply still remains an exceedingly difficult problem shared by national-forest administrators and by hundreds of stockmen throughout the West. Illustrative of this difficulty is the fact that proper seasonal use still needs to be brought about on approximately 12 percent of the 9,000 grazing units on national-forest ranges.

To the individual operator, the risk of range injury, if considered at all, usually has been regarded as outweighed by the economic necessity. That early spring injury has been occurring for years on years, however, is shown among others by results of studies in Utah (*116*), in Colorado (*65*), and in North Dakota (*119*), as well as by much general observation elsewhere through the West. When cattle are allowed to "follow the snow" and forage is cropped "as soon as it pokes its nose out of the ground" no plant factory is left to manufacture food to replace that gradually sapped from the scant supplies still stored in the roots in spring. Further injury to both plants and range results from trampling of saturated soils.

It is of especial interest to note that the detrimental effects of summer invasions of Montana winter range by herds and flocks—another example of improper season of use—was referred to, as early as 1900, as "the denuding summer pasturing" (*49*).

Risk of damage to range and loss of condition of animals also is usually incurred in any attempt to graze short-season ranges for a longer period. For example, on certain California foothills, chiefly valuable for fall, winter, and spring grazing, the short-lived annual forage dries to a crisp in May, and during the long practically rainless summer provides an unsatisfactory ration deficient in vitamin A (*68*), and certain minerals, particularly calcium and phosphorous—a deficiency usually associated also with low protein (*67*). If such ranges are grazed yearlong not only is it usually necessary to supplement them to prevent serious loss in animal condition; but, in addition, little or no old grass remains on the "slicked-off slopes" at the beginning of the fall rains, to retard erosion.

Full-season use of the browse ranges of southwestern Utah—areas better adapted to late spring and fall grazing—is followed by a

gradually diminishing stand of the most palatable bushes (*68*)—another illustration of grazing at the wrong time of year.

The time of grazing has much to do with livestock damage to timber on the Coconino Plateau of Northern Arizona, according to studies of the Southwestern Forest and Range Experiment Station. Most of the grazing injury from browsing of terminal shoots of ponderosa pine "reproduction"[16] occurs when the proportion of succulent forage is smallest. This condition exists each year during two dry seasons, the first from the opening of the grazing period about June 1 to the beginning of the summer rains in early July, and the second and shorter period extending from about the first of October to the end of the grazing season. Lack of proper consideration of the amount of succulent forage available during these critical dry periods has been the principal cause of damage to the regenerating forest. This appears to be even a more important cause than shortage or poor distribution of water.

POOR BALANCE BETWEEN CLASSES OF ANIMALS AND TYPE OF RANGE

Local failure to allocate ranges to the class of stock to which they are best suited reacts unfavorably on both stock and range. Illustrations of such maladjustments, as they affect ranges, include (1) placing cattle on ranges so rocky and rugged that animals become footsore, calf crops are reduced, and the most accessible areas are overgrazed (*79*); and (2) vainly attempting to get full utilization with cattle of ranges supplied with sufficient water for sheep but not enough for cattle.

Sheep, for example, require water less frequently than cattle[17] (*78*), and consequently can travel farther between feed and water. From the standpoint of forage alone, full stocking of such areas with cattle is inevitably reflected in enlargement of the trampled-out areas around water, increased soil washing, and reduced grazing capacity—the same chain of destructive results discussed in detail in foregoing paragraphs.

Placing both cattle and sheep on the same range usually is equivalent to double use, with its attendant evils. The principle of this so-called "common use" originated from the belief that full utilization of all the forage (maximum grazing capacity) could best be attained by grazing on the same range two or more classes of livestock in numbers corresponding to the quantity of forage that could be used by each class. On numerous ranges where all conditions have been favorable, common use has worked (*79*). In too many instances in actual practice the attempt at common use has culminated in double use and in overgrazing in varying degree. To just that degree the practice, as it concerns domestic livestock, has proved injurious.

Dual use by domestic livestock and game likewise requires planned regulation to avoid detrimental overuse. In general, there is ample summer range on western forests for present numbers of game animals, and in most cases for increases, without conflict with domestic livestock (*154, pp. 527–554*). A general deficiency exists, however,

[16] Small trees between the seedling and sapling stages.

[17] United States Department of Agriculture, Forest Service. Report of the District Investigate Committee, District 3. 134 pp. 1930. [Mimeographed.]

in winter range, which includes several million acres of public domain, a large but unknown acreage of privately owned wild land, and the lower fringes of national forests, national parks, and State parks. Much of this winter range for deer, elk, and antelope is badly overgrazed (*149*), the results being similar to those caused by livestock alone. The spectacular examples that have aroused national interest and concern, illustrate the problems.

The deer herd on the Kaibab National Forest in Arizona increased so rapidly with complete protection that within 5 years after the peak had been reached about 1924 [18], and despite a heavy reduction in livestock, the productive capacity of much of the winter range had dwindled to 5 or 10 percent of the normal forage supply (*164, pp. 489–525*).

The second example concerns the Sun River elk herd on the Lewis and Clark National Forest in Montana, which reached an estimated total of 4,600 in 1930, with available winter range badly overgrazed. Severe winters, hunting, and other causes have reduced the total to about 3,000 head; but, in spite of a reduction of 78 percent of the domestic livestock on the area, further adjustments must still be made to halt the damage.

THE EFFECT OF BURNING ON FORAGE PRODUCTION

Any painstaking analysis of the vexing problem of burning and forage production on the so-called "brush ranges" of the West reveals two major causes: (1) Local confusion and even misunderstanding because of lack of accepted facts on critical phases of the problem; and (2) the occasional inevitable clash of two schools of thought. One group includes some stockmen and others who are faced with the problems of making a living off the range land and have only a mild or secondary interest and concern in its public values. Perpetuation of the basic resources, however, is the obligation of other groups. Quite sincere differences of individual and group opinion are thus involved.

Whether to burn chamise and chaparral lands in California, for example, is a question that has received much general empirical study and observation, supplemented on certain points by detailed studies, chiefly by A. W. Sampson, of the University of California. As temporary advantages of burning "brush" lands, the findings of these studies include, among others, a usual increase in volume of forage and a longer period of succulence for the first year and to a lesser extent during the second year after the fire. Proponents of burning consequently minimize the disadvantages, taking the position that the increase in forage more than compensates for any injury to the range resource.

As an offsetting detrimental finding, however, the increased amount of forage on "burns" is not only very temporary but it is usually obtained through the barter of fertile soil; for soil erosion is increased by burning on the steeper, rougher areas. For these reasons, conservation groups and administrators charged with maintaining productivity of these lands, most of which are included in

[18] Mann, W. G., and Locke, S. B. The Kaibab Deer, a Brief History and Recent Developments. U. S. Dept. Agr. 67 pp., illus. 1931. [Mimeographed.]

important watersheds, hold the view that on most areas serious injury to the range soil, to the watersheds, and to other public and long-time values outweighs the temporary value of the increased forage.

With reference to sagebrush ranges, observations by Pickford (*104*) in the Intermountain Region, indicated that promiscuous burning followed by unregulated grazing tends to deplete the stand of perennial grasses and to allow inferior annual grasses to increase in abundance.

The further point should be made clear that many stockmen apply the term "brush range" not only to the chaparral-covered foothills or to sagebrush plains, but also to ranges in the ponderosa pine type in which young timber has crowded out livestock forage in varying degree. In order to hold and increase the area available for grazing, stockmen occasionally have favored burning of such commercial timberlands. The damage resulting from such a practice is great.

In mature timber not only is there a large direct loss in volume but subsequent loss results from decreased growth and from fungous and insect damage (*129*). A more serious result from the burning of cut-over lands is the progressive destruction of both small and established tree seedlings and the "taking over" of large areas by dense stands of worthless brush. For example, of 13.6 million acres comprising the largest part of the California pine region, 1.9 million acres of potential timber land are now brush fields resulting from fires (*128*).

And of even more far-reaching importance is the fact that repeated burning of mountain timberlands enormously increases erosion of the fertile topsoil, a fact demonstrated by the California Forest and Range Experiment Station and other agencies. As an illustration, based on actual measurements from experimental plots in one locality, run-off from bare burned soil was shown to be 3 to 30 times greater than that from adjacent forest-covered soil; and the erosion 100 to 1,000 times greater, the higher rates coinciding with higher intensities of rainfall.

Combined Effects of Unsound Rule-of-Thumb Practices

The foregoing factors in depletion resulting from rule-of-thumb management have brought about sadly reduced forage values in all parts of the West. Fully half of the western range area, according to recent estimates, is now characterized by severe or extreme depletion as given in detail on page 114 and summarized in figure 59. For example, on open desert ranges in Nevada forage attains only 49 percent of its former value; in Utah, 36 percent; and in the Red Desert of Wyoming, 43 percent of that in the remnants of protected range that are still left, as shown by surveys made by the Intermountain Forest and Range Experiment Station. Moreover, even the protected fragments are thought to be less productive than was the virgin range. This depletion is recognized by resident stockmen who have operated 20 to 50 years on one or the other of these three range units. The older range users have estimated reductions of 20 to 80 percent from the original condition, the amount of their estimated reductions corresponding in general to the time they have

used the range. The story is similar in various other types of western range.

Such heavy reductions in forage values constitute a heavy blow to the grazing industry, because the salt-desert-shrub type is the principal winter range over extensive areas in the intermountain region. Even in their depleted condition, these desert ranges support nearly 2 million sheep from 4 to 6 winter months in Utah; more than a million use them for 3 to 5 months in central Nevada; and probably 2 million use them for 3 to 5 months in Wyoming and Colorado.

How much of the present alarming condition may fairly be charged to the rule-of-thumb basis of attempted management, and how much to drought and other causes? Adverse climate has peri-

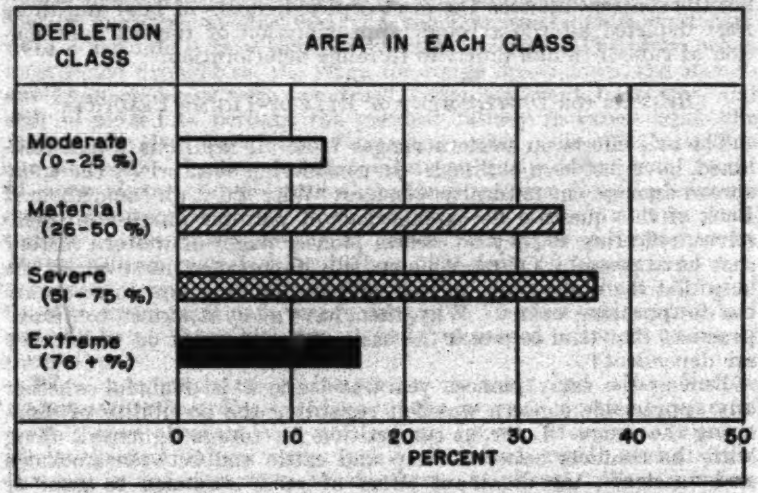


FIGURE 59.—REDUCED GRAZING CAPACITY OF WESTERN RANGE

Less than one-seventh is still in comparatively satisfactory condition, and this portion is more than outweighed by the area on which most of the values have been lost.

odically been a potent contributing factor in the temporary depreciation of many range areas; for, as earlier explained, climatic fluctuations affect in pronounced degree both range forage and productivity. Drought reflected in a reduced forage crop quickly converts what is normally a proper stocking into excessive stocking, and intensifies the damage to ranges already too heavily stocked. But this depletion due to drought alone is only temporary, as explained in a foregoing section; for drought-stricken ranges recover following the return of favorable growing conditions—unless the drought is accompanied (as in recent years it almost invariably has been) by excessive stocking or other bad practices. So, in the long run, it is these rule-of-thumb practices—not climate—which cause ranges to break down.

This conclusion is further strengthened by the especially significant fact that range depletion is rather closely tied in with the class

of land ownership, range deterioration being generally greatest on unregulated, publicly owned lands as well as on the majority of those privately owned; and least on publicly owned areas under regulation and on the notable exceptions of well-managed private holdings. This is not surprising for, as explained later on in this chapter, financial difficulties brought about by overcapitalization, onerous credit facilities, and unstable and fluctuating markets have contributed in no small way to poor husbandry, range exploitation, and the inevitable consequence—range depletion, on free public range and most privately owned range.

Most depletion, then, results directly from overgrazing, which in turn has its origin in defective range-management practices as just explained. The exact amount of depletion properly attributable to these rule-of-thumb practices cannot of course be accurately weighed, but the contrast between the most depleted classes of land and those least depleted affords a rough approximation of the net contribution of rule-of-thumb practices to range deterioration.

Reasons for Development of Rule-of-Thumb Practices

The evil effects on western ranges from all injurious forces combined, have just been outlined. In considering even briefly the widespread damage one naturally wonders: "Why did it all come about?" Back of this question lie explanations of peculiar interest in themselves, reflecting as they do certain pioneer pages of western history that have passed. Of more immediate importance, however, is the help that the underlying reasons offer in planning how to recapture the disappearing values. Why, then, have many stockmen continued practices that tend to wreck the basis of the industry on which they are dependent?

During the early pioneer years at least, it is doubtful whether any appreciable concern was felt regarding the possibility of damaging the range. Later, as competition for forage tightened, along with the conflicts between sheep and cattle and between stockmen and "nesters", the dominant effort of most stockmen to gain or retain control of the range overshadowed any thought of resultant damage, and led even at times to the malicious "trampling into dust" of areas of feed, to drive back crowding neighbors, or in retaliation. No responsibility was felt for preserving the ranges for the future. As Barnes (*14*) points out, it was all free, open grazing; Uncle Sam owned it, and "it was a clear case of first come first served and the devil take the hindmost"—virtually the motto of that period. And, permeating each and every chapter of the story of the range—even to the present—maximum immediate profit rather than maintained range productivity usually has been the accepted individual aim. Proper management may also be hindered by local conditions. For example, stockmen using the unregulated public domain, are still to a considerable degree, forced deliberately to overgraze the range in order to discourage competition.

Moreover, vastness of open range and abundance of forage at time of first settlement discounted any need for concern. Perhaps, however, in the words of Barnes:

> The stockmen of those pioneer days should not be held to too strict an accountability for their range practices. It was all a new proposition to them.

Few of them knew the first rudiments of forage growth or plant requirements. They mostly grew up with the pioneer idea that when the feed in a certain region was gone there was more "over the range" to which they could move their herds and flocks.

In a surprisingly large number of instances stockmen did not realize the wide differences in range-plant palatability—a vital foundation stone of safe grazing capacity. When all the choice range had been taken up and overstocking and other rule-of-thumb practices, together with drought, began to take their combined toll, range depletion continued without any general realization on the part of stockmen that the range could not withstand the severe treatment indefinitely. Most of them failed to take into account the penalty of guessing at grazing capacity and the forage-crop ups and downs resulting from climatic fluctuations.

The delicate balance between climate and vegetation was completely unknown to stockmen and the interested public, and both were lulled into a false sense of resource security. Therefore, when unexpected drought set the stage for range break-down, the attendant livestock losses were bemoaned, but complacent faith was, and still is pinned to perhaps the greatest fallacy in range land—the far-too-prevalent belief that "one good rainy year will bring the ranges back." Studies to date indicate precisely the contrary result in many western range types where the important forage plants are dependent upon seed for their perpetuation. A convincing illustration of the slow recovery of bunchgrass types is furnished by Forest Service records from 1912 to 1935 from 50 quadrats on Arizona pine ranges that were overgrazed when established. None of these regained maximum forage density in 12 years under fence and four-fifths of them had not entirely recovered after 21 years of protection.

Then, too, much range damage in its early and often obscure stages occurred undetected, because the average stockman, in most ways a keen observer, was not looking for it. Moreover, in many places the first danger signs, such as incipient erosion and a slight increase in inferior range weeds, were not always reflected immediately in livestock condition. Finally, there was a lack of depletion "yardsticks"—criteria by which the significance of these first changes could be understood.

Locally, observant stockmen, of course, did realize the full import of these changes—and a long time ago. The secretary of the California Wool Growers' Association, for example, in writing in 1863 of conditions in that State (*101*) alluded to sheep ranges:

> Where the lands have been so persistently overstocked [that] the herbage has necessarily become thinner and thinner * * *. This process of depasturage, though not confined to any one species of herbage, is most strikingly exhibited in the great oat ranges. * * * This system of stocking the grazing lands must ultimately result in their entire depasturage. * * *

Thus a note of alarm regarding overstocking and range decline in one region, the Pacific coast, was sounded from within the livestock industry itself nearly three-quarters of a century ago.

Even when recognized, damage has frequently been tolerated by private owners because of economic pressure, including such policies as the deliberate holding over of excess numbers of animals for another year because of poor markets; taking a chance on a little

range damage in order to save money on costly feed; and pushing herds onto mountain ranges too early in the spring before the range was ready for grazing. Locally, many national-forest range areas likewise have suffered through attempts to relieve temporarily the strain on the local stockmen and local communities, in response to strong pressure during emergency periods of feed scarcity; and from the added strain of increasing livestock in an effort to increase meat production in 1918.

Finally, in a review of the reasons underlying past range practices, one must keep in mind that the pioneer stockman was forced to improvise untried rules. Previous husbandry—developed in eastern agriculture on comparatively small areas, with more uniform forage types, and more gentle stock under fenced control—fell flat when it came to handling sheep in bands as large as 3,000 head (*98*); tens of thousands of cattle in single ownership, and in at least one instance the almost incredible total of 150,000 head (*118*). Both classes of stock had to be handled over ranges extending from the smooth to the inaccessibly rough and from sea level to elevations above 12,000 feet, characterized by wide extremes of climate, and supporting hundreds of strange forage plants. New complex situations had to be met, and promptly. Rule-of-thumb methods quite naturally were resorted to by stockmen, and to some extent have been retained by public-land administrators in the absence of sufficient proved facts.

Even had more tested experimental results been available, a lag in their application was perhaps inevitable, especially on the part of the pioneer who, in the main, was the sturdy confident type that pushed back frontiers. One must keep in mind that the isolation, uncertainties, and emergencies of those times fostered reliance on independent judgment by early ranchmen, naturally a highly independent class who preferred opinion or practical experience to outside counsel regarding the conduct of their business. Consequently, within the industry itself there has not been any general appreciation of the value of tested information in meeting the changing western conditions. From this viewpoint the grazing industry stands in sharp contrast to farming with its sustained emphasis on research as a highly useful adjunct to practical management. Thus the lag in range research also may be regarded as one of the major reasons for the long-continued use of many rule-of-thumb practices. Because of its importance it is discussed in a separate section of this report.

THE LAG IN RESEARCH AND EXTENSION

By M. W. Talbot, Senior Forest Ecologist, California Forest and Range Experiment Station, and E. C. Chapin, Assistant Forest Ecologist, Southwestern Forest and Range Experiment Station

Management of western ranges with their intricate and variable pattern of conditions and their interlocking private and public values is not an easy job. Livestock forage is not their only crop. They possess, in addition, important watershed, wildlife, recreational, and timber values. To keep pace with rapidly changing conditions western range management already requires, in addition to the contribution of sound practical experience, much detailed knowledge not yet available. Yet, as previously pointed out, interest in basic fact finding has lagged far more on range problems than, for instance, on farming problems. As the men charged with range administration began building up the system of regulated grazing on public range lands, the incentive for digging out new needed facts had to come chiefly from land-managing conservation groups. Consequently, the realization of the need for range research has developed slowly.

Appraisal of Range Research and Extension [19]

Research on problems concerned with range land use thus far undertaken in the United States may be appraised by discussing briefly duration of the work, character of investigations and agencies engaged, expenditures, number of workers, and application of results in range extension.

DURATION OF WORK

The United States was one of the first countries to undertake research on range-land problems. Investigations by Federal and State agencies began about 1900, and by 1910 eight State agricultural experiment stations had each pioneered one or two projects. In 1907 the Forest Service initiated range investigations in connection with administration of the national forests and in 1910 established the Office of Grazing Studies. Twenty-five years earlier, however, when the great cattle boom of the eighties was at its zenith there was an acute but unrecognized need for research results. Had the facts been known then concerning grazing capacity, seasonal use, and the economic consequences of range abuse, much of the disastrous depletion that began with the boom period and grew with succeeding expansion, might have been avoided. Research started about a quarter of a century too late, and has never been on a scale commensurate with requirements.

[19] In preparing this section, reference was made to publications and unpublished records of the Department of Agriculture, the Forest Service, the Office of Experiment Stations, the Bureau of the Census, the Bureau of Animal Industry, the Bureau of Plant Industry, the Bureau of Agricultural Economics, and the Western States Extension Conferences.

CHARACTER OF INVESTIGATIONS

The Forest Service, charged with departmental responsibility for research on timbered and nontimbered ranges both within and without the national forests, is the only agency that has developed a comprehensive range-wide investigative program. Its work centers on the range resource itself and is only incidentally concerned with the handling of livestock. Emphasis has been on the determination of the principal forage plants, their growth habits and forage value, on range management, including natural revegetation and principles of grazing use, and on the relation of range use to watershed protection. Some progress has also been made on the effects of grazing on forest reproduction, and on plant succession—how vegetation is affected by grazing, drought, and other influences.

Forest Service range research is now confined to a limited number of the important classes of range in five major regions in the West. It is urgently needed, and should be extended to all the principal classes and to the Pacific Northwest.

Eight other Federal agencies, six in the Department of Agriculture, either have cooperated with the Forest Service or have worked independently on the range problems within their jurisdiction. For example, the Bureau of Plant Industry in the early days investigated certain phases of range revegetation, and more recently has devoted increasing attention to pasture problems, development of forage crops, and plant breeding. The Bureau of Animal Industry has studied animal husbandry and poisonous plants; the Bureau of Agricultural Economics, cost of production, ranch organization, and other range-land problems. The Biological Survey has studied wildlife; the Bureau of Entomology and Plant Quarantine, insect problems; and the Bureau of Chemistry and Soils, plant analyses and soil problems relating to range lands. The Bureau of the Census of the Department of Commerce has for many years collected statistical data on livestock, livestock products, pastures, forage crops, and farms and ranches. The Tariff Commission has conducted investigations of manufacturing costs and returns on such range products as wool and beef cattle.

The State agricultural experiment stations in each of the 17 Western States have individually undertaken some work on a variety of problems, centering on range management, animal husbandry, and economics. Limited research is under way at most of the 13 colleges and universities that offer detailed work in grazing. The Carnegie Institution of Washington and the Boyce Thompson Institute for Plant Research have both investigated problems that bear directly or indirectly upon range vegetation.

The research by all agencies for convenience of comparison may be arranged in three groups. The most effort has been expended in group 1, the least in group 3. None, however, has adequately met the needs of the problems.

Group 1	Group 2	Group 3
1. Range management (systems of grazing, livestock distribution, etc.). 2. Range botany. 3. Range animal husbandry (breeding, supplemental feeding, diseases, etc.). 4. Range ecology (changes in range vegetation under various influences and treatments).	1. Natural revegetation. 2. Effect of grazing on forests. 3. Range economics. 4. Artificial reseeding. 5. Nutritional value of range plants (including chemical analyses). 6. Watershed management.	1. Grazing capacity. 2. Range wildlife. 3. Degree of utilization. 4. Range soils. 5. Range weather. 6. Range entomology. 7. Range plant breeding.

Both the number of agencies engaged in research on range problems and the number of range-research projects undertaken—90 by the Forest Service and 140 by the State agricultural experiment stations—give a misleading impression of the amount of effective and lasting work performed. Many of the agencies are interested in only one or two local problems; and emphasis in their research, which is often empirical in character, depends to an appreciable extent upon individual initiative rather than upon a planned, coordinated investigative program. Many of the projects, particularly in the early days, were small part-time jobs for one man, requiring less than one man-year of work for completion, as, for example, the chemical analysis of a poisonous range plant. Moreover, a great deal of the first work was as much range extension as research, consisting in a large measure of experimental demonstrations designed to create among range land administrators and stockmen a better understanding of range problems and their important phases. A considerable portion of the early research, although of real value at the time, was empirical and extensive in character, and has been shown in the light of subsequent intensive investigations to have little application to present-day conditions except to solve local problems and to serve as background for future studies. Effective research, that comprehensively attacks region-wide problems and determines urgently needed facts, is largely a development of the last decade.

The Forest Service has effectively organized and coordinated its effort between various problems, lines of work, and range regions. It has recognized the national significance of range research and planned the comprehensive range-investigative program explained in detail later in this report.

EXPENDITURES

It has been estimated that 100 million dollars are spent annually on research in the United States. Nineteen million was spent by the Federal Government alone in 1933; of this, research on range problems in all their aspects, drew not over $175,000, or less than 1 percent. An additional $75,000 was invested by State agricultural experiment stations. In 1900, range livestock was valued at approximately 280 million dollars, but only a few hundred dollars of Federal funds were spent in range research proper. By 1930, the range-livestock value had increased to 770 million dollars, and about $180,000 was expended in Federal range research, or about 0.02 percent. Contrast this with relative expenditures for research in some other agricultural industry such as poultry or dairying. In 1930, the value

of range livestock exceeded the value of poultry raised by 120 million dollars and yet no more Federal money was spent for range research than for poultry research, all of which was essential. From 1900 to 1930 the value of dairy products has consistently been from two to two and one-half times the value of range livestock. But during the same period Federal expenditures in dairy research have exceeded those for range research by 350 to 400 percent. Considering the greatly increased values that have come from these dairy studies, no one would question the desirability of continuing or even expanding them.

Federal expenditures in research on range problems are limited almost exclusively to the Department of Agriculture.

From incomplete estimates, the value of range livestock and corresponding Federal expenditures in range research expressed in dollars and percent of value are as given in table 29.

TABLE 29.—*Comparison of livestock values and range research 1915–30*

Year	Value of range livestock	Expended for Federal range research		Year	Value of range livestock	Expended for Federal range research	
		Amount	Percent			Amount	Percent
1915	$530,000,000	$50,000	0.017	1925	$650,000,000	$100,000	0.013
1920	810,000,000	75,000	.009	1930	770,000,000	130,000	.017

NUMBER OF WORKERS

There are probably less than 100 technical workers devoting their full time to research on range problems in the United States today. Because much of the work is not full time and varies greatly from year to year, it is impossible to estimate accurately the total man-years of work done in any calendar year. A generous estimate would be 125 man-years of work annually. The Forest Service performs about 45 of these man-years of work, other bureaus of the Department of Agriculture about 25, the State agricultural experiment stations about 45, and the remaining 10 are scattered among colleges, universities, and other research agencies.

Approximately 50 percent of these workers are engaged in research on conservation and management of the range forage resource, which includes investigations in range and watershed management, range reseeding, range botany, etc., 20 percent are in range-animal husbandry, 15 percent in range economics, largely at the State experiment stations, and the remaining 15 percent are distributed in the fields of range wildlife, range weather, range soils, and range entomology.

RANGE EXTENSION

Range extension is the making available to stockmen and rangeland administrators by demonstrations, discussions, addresses, and publications the results of studies and experience. Although research on range land problems has been far from adequate, the results that have been obtained have not been applied on the ground to their fullest possibilities. One main reason has been the lag in

extension work which is the intervening step between research and the practical application of its findings.

In the United States, range extension was to a large degree merged with research until about 1920, and was practically nonexistent as a distinct activity. Since 1923, when a definite range-extension program was first formulated, the extension services of the State agricultural colleges, cooperating with the State agricultural experiment stations and the United States Department of Agriculture, have reported a limited amount of work in each of the 11 Western States, principally in animal husbandry, rodent control, and improved grazing methods. Despite admirable results from the demonstrations and other work already performed, extension specialists attribute the pronounced lag in range extension primarily to (1) high cost of demonstrations, which in order to be effective involve comparatively large areas and herds of sheep or cattle, and (2) inadequate control and administration of the unregulated public domain, resulting in an indifferent attitude of many stockmen toward improved range methods.

Examples of Neglected Unsolved Problems of Range Restoration and Management

Studies undertaken to date, as thus outlined, have covered a rather wide scope and have contributed highly useful data; but actually they represent a thoroughgoing attack on only a small fraction of urgent vexing questions that constantly arise to plague the stockmen and land administrator. Facts, clinched by convincing proof, on complex and controversial points are especially inadequate for correction of much range depletion. This serious lack of basic management information applies over a surprisingly large sweep of problems relating to range plants, to animals, and to their environment.

What are some of these challenging management problems of both public and privately owned grazing lands? A few examples will indicate how far research must still go to provide an adequate basis for their solution.

Problems of Grazing Capacity

General studies and observations on grazing capacity have for sometime been conducted throughout the West, but intensive studies have been started in only a few places and on a few kinds of range, and chiefly within the last decade—years after their need was painfully apparent. As for other agencies, in the 17 western range States with their multitude of different forage types and varying management needs, only seven State agricultural experiment stations (New Mexico, Arizona, Nebraska, Nevada, North Dakota, California, and Washington) had published by 1920 results of grazing capacity studies. Even in 1930 (*15*) only two additional stations (Colorado and Texas) were undertaking even limited work in this field (*155*).

Research on grazing capacity has not yet been conducted on many important western range types.

THE ROLE OF VEGETATION IN WATERSHED PROTECTION

Western grazing lands no longer are valued for their forage crops alone. In fact, on many areas, as will be made clear later in this report, forage values are far outweighed by watershed values which directly or indirectly affect big populations and enormous investments in agricultural and urban facilities and industries. It is imperative, therefore, that management of range lands that are also watershed lands take into account their future productivity not only of forage but also of usable water, the most valuable "crop" in many localities of the West. The objective on such lands is a type of management that so far as possible will harmonize grazing with watershed needs.

Protection of watersheds, one of the primary reasons for the establishment of the national forests, has been given special consideration by the Forest Service for 25 years and more. Noteworthy among the findings of studies and controlled experiments which have been conducted in several localities, is the further evidence, both vegetational and geologic, of the influence of plant cover on surface runoff and abnormal erosion, in relation to grazing. Western ranges and watersheds, however, comprise a complex pattern of soil, topography, vegetation, and climate. Consequently, numerous phases of this big problem, so closely tied in with the welfare of western communities, remain unhandled.

The local and national importance of these problems pertaining to forage-and-forest influences, discussed in detail later in this report, argues for the speedy gathering of a more adequate supply of measured facts.

KEY FORAGE PLANTS

What are the most important range plants in the various grazing types and regions, evaluated as to their growth requirements, forage value, or response to climate? Nelson (*93*) has shown, in connection with growth requirements and limits of resistance to grazing, that utilization of black grama in excess of 80 to 85 percent of the foliage at the end of the grazing season results in smaller forage crops in succeeding years. But what is safe closeness of use for many other important forage plants and types in other regions? Also, from the dual standpoint of animal nutrition and forage maintenance, what is the proper season of range use, type by type? And again, much observational information has been gathered throughout the West; but detailed data are available for only a few localities and a few sets of conditions.

What is the exact effect of climate on forage plants and on forage yield? A relatively small amount of investigation at the Southwestern, Intermountain, and Northern Rocky Mountain Forest and Range Experiment Stations, the Arizona and New Mexico Agricultural Experiment Stations, and the Carnegie Institution of Washington has yielded detailed data, but on only a mere fraction of the important range plants of the West. The species studied vary greatly in behavior; what about the other equally important plants and their relation to range management? Meager data and general observations of protected plots have further shown the wide fluctuation in forage yield and grazing damage between successive years,

but the combined range damage from drought, overgrazing, and, locally, rodents has not been unscrambled and the causes separately evaluated.

ARTIFICIAL REVEGETATION

What are the possibilities of successfully restoring the grazing and watershed-protective values of depleted ranges by artificial means when nature is too slow? The complete answer to this very practical question is not yet known. The opportunities offered for range revegetation by direct seeding or transplanting of native forage species or exotics have never been adequately explored. Still, the work already done in this field, with a limited number of plant species, indicates considerable promise under favorable conditions and has pointed out the need for more comprehensive testing.

Success has been attained in numerous depleted mountain meadows. Obviously, however, species that are suited to high mountain areas on which precipitation is favorable are not generally adaptable to the more arid foothill and desert ranges at lower elevations. What forage plants can be established successfully on depleted portions of these semiarid grazing lands? What are the limitations in site, in time, and in cost? What possibilities are there for improving species or strains of range plants? What are the practical tests for determining which treatment is most practicable: (1) Artificial revegetation, (2) natural restoration, or (3) a combination of the two? The Bureau of Plant Industry and the Forest Service—the pioneers in this field, along with the several State agencies—have shown that, within limits, artificial revegetation holds much promise. But a maze of unsolved problems lies ahead.

INTERPLAY OF ANIMAL FACTORS IN THEIR EFFECT ON RANGE

Only the merest start has been made on the complex problem of forage provision and management for game animals on livestock ranges. Wildlife management is just beginning to receive widespread attention from the research angle. As yet few studies have yielded a scientific basis for dealing with large numbers of both classes of animals. Meanwhile, local overgrazing of jointly used ranges continues.

Illustrative of the unsolved nature of problems in the wildlife field is the difference of opinion relative to rodents. Any attempt to evaluate rodents in relation to range at once raises the question: Are rodents beneficial or detrimental? Or, more specifically, are rodents, particularly pocket gophers, an essential factor in preserving the proper plant cover on the range, or are they a factor in range depletion including erosion? Obviously, the questions have many angles and various answers, depending on the species of rodent, the kind of range, and other local conditions. Adequate factual information upon which to settle these questions is lacking. Uncertainty and local controversy have, of course, resulted. The greatest immediate need is additional research concerning the life histories of range rodents, the relations between burrowing animals and watershed conservation, and the influences of burrowing animals upon the range vegetation.

NEED FOR SIMPLE, USABLE MEASURES OF RANGE CONDITION

In shifting attention from range animals to the range itself, one encounters a widespread need for simple, usable measuring sticks of range condition. This need is especially surprising in view of the fact that considerable attention has been devoted quite logically to the old but still moot questions: What constitutes proper utilization? Or overgrazing? For certain types and plants, more particularly on the national forests, fairly adequate indicators of range condition are available. In dealing with the less obvious conditions, however, and with unfamiliar vegetation types not yet studied in detail, size-ups of range condition lack uniformity, invite unrecognized damage, and may even become controversial—and they are likely to so continue until more simple, usable measuring sticks, demonstrable on the ground, are available. Their development constitutes a real challenge to research.

MANY OTHER UNSOLVED PROBLEMS

In addition to these examples of unsolved or partially solved problems, a long list of other important ones in such fields as forage values, range-plant moisture and other site requirements, range-plant breeding, range economics, soils, and range entomology are indicative of the scope of the research job ahead. A multitude of facts must be unearthed to answer such questions as: (1) How may western range condition be recognized and evaluated with greater certainty and simplicity? (2) How may range forage be most adequately improved and maintained and range soil safeguarded? And (3) how may the range as a basic resource be handled to make its maximum contribution to social welfare?

The Net Result—A Concluding Appraisal

In essence, there are two—and only two—approaches to land-management policies and practices: (1) The slow evolution of rule-of-thumb large-scale trial-and-error experience, and (2) tested facts. The rule-of-thumb approach, by and large throughout the West, has failed thus far to develop management that has stood practical test as witnessed by the practically universal depletion. Research has been, and still is, woefully inadequate in furnishing proven facts to strengthen, where needed, a better factual basis of management. Many needed management facts have accumulated too slowly for maximum effectiveness; and on other problems, no studies have as yet been started. The meager yield of experimental results on obscure or controversial points has never caught up with the increasing need. The resultant lack of dependable information on especially complex problems has thus failed to provide a basis for curbing much continuing depletion, has retarded application of corrective measures on Federal lands, and has delayed extension efforts among private owners.

FINANCIAL HANDICAPS

By E. I. Kotok, Director, California Forest and Range Experiment Station

A number of financial handicaps faced by the range livestock producer have tended to prevent the most effective balance between capital investments, production costs, breeding herds, credit facilities, and marketing opportunities. Since a seriously unbalanced relationship adversely affects the opportunity for profit, and therefore tends to affect the management of the range, an understanding of the handicaps is needed.

The livestock producer has not been entirely a free agent to manipulate at will the elements that enter into production costs, nor has he been able to adjust these with the constant fluctuations in the market price of his ultimate salable product. This section will attempt to explain the ways in which financial factors largely beyond the control of the producer have influenced business management and range practice, tending toward range depletion.

The Relation of Capital Investments to Profits and Range Depletion

The home ranch, the range, the breeding herds, and the other required improvements and facilities form the production plant of the livestock business. For continued and sustained returns these elements must be in balance with each other and with the salable annual output, otherwise potential profits may be converted to actual losses.

The percent of the total investment carried in lands, herds, improvements, and facilities varies markedly from operator to operator, but there are general and distinct regional differences and also characteristic variations between cattle and sheep outfits. These variations are considered as they influence profits, range-management practices, and range depletion.

In table 30 the percentage of the capital investment in each of the major inventory items is given. These are composite figures and represent approximations based on a series of studies conducted by the State agricultural experiment stations and the United States Department of Agriculture. The data available present difficulties in the segregation of the items and distinct limitations in making regional or periodic comparisons. The range livestock enterprise varies widely, from the farmers who have a few head of stock providing a supplemental source of income, at one extreme, to the livestock producer owning 50,000 sheep or 10,000 cattle on the other end of the scale. Obviously, summaries covering such vast differences in size of units must either include all ranches in a region or must be carefully selected samples. Another difficulty is that continuous records on the same sampled ranches do not cover an extended period of time; neither are the fluctuations in the commodity value

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of the dollar considered in all studies. But even with these limitations, the significant trends between regions may be safely singled out.

TABLE 30.—*Approximate percentages of capital investments in the livestock industry in major items, for 6 regions*

Region	Cattle outfits			Sheep outfits		
	Herds	Land	Other	Herds	Land	Other
	Percent	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*
1. Montana and North Dakota	38.0	50.0	12.0	56.0	37.0	7.0
2. Colorado, South Dakota, Wyoming, Nebraska, Kansas	42.0	48.0	10.0	52.0	38.0	10.0
3. Arizona and New Mexico	52.0	31.0	17.0	55.0	31.0	14.0
4. Utah, Idaho, Nevada	43.0	45.0	12.0	56.0	33.0	11.0
5. California	40.0	50.0	10.0	53.0	35.0	12.0
6. Washington, Oregon	38.0	50.0	12.0	50.0	39.0	11.0

The composite average indicates that somewhere near 50 percent of the capital investment in the cattle industry is in lands, 40 percent in herds, and 10 percent in improvements and facilities. In the more settled regions, where land prices are higher, the investment in lands is above this average. As shown in table 30, less than a third of the investments for Arizona and New Mexico is in lands and more than half in herds. In part this may be explained by the fact that this region includes extensive areas of public domain and national forests used for grazing. There is, however, in this region a correspondingly greater investment required for improvements which the livestock owner has been forced to build on the public range.

For sheep the average percentage of investment in land varies from 31 percent in the Southwest to 39 percent in the Pacific Northwest, and in herds from 50 percent in the Pacific Northwest to 56 percent in eastern Montana, North Dakota, and also in parts of the inland empire.

The important inferences that may be drawn from these data are that all through the range country, except in the Southwest, the cattleman has had to invest relatively more heavily in lands than the sheepman; that Arizona and New Mexico producers have less investment in lands and correspondingly higher percentages in herds for cattle than any of the other regions; that Utah, Idaho, and Nevada sheepmen have also a relatively low percent of investment in lands and a correspondingly higher percent in herds.

The percent of the total investment in lands or in herds varies materially as the price of livestock goes up or down. While both lands and livestock have irregularly risen in unit price, the former has been more stable with a general upward trend and the latter has fluctuated within wide margins. This in effect means that if the figures in table 30 represent individual years when livestock unit prices were high, the percentage shown as invested in stock is relatively higher than it would be over a number of years. Most of the data are from studies conducted in 1927–28, when livestock prices were high, which means in effect that the actual percentage given as the investment in lands is lower than it would be over extended periods. The general rise in livestock unit prices and the periodic changes are illustrated by data given in tables 31 and 32.

TABLE 31.—*Trend of range-cattle prices, in actual value per head, and in relative purchasing power of the dollar, 1867–1933*[1]

Year	Actual value	Relative purchasing power	Year	Actual value	Relative purchasing power
	Dollars	*Percent*		*Dollars*	*Percent*
1867	15.70	44.2	1902	18.76	95.8
1873	18.13	62.6	1907	17.10	77.7
1877	15.99	60.7	1912	21.20	93.3
1882	18.80	84.0	1917	35.88	97.2
1887	19.79	103.3	1922	33.80	71.3
1892	15.16	83.2	1927	30.87	84.2
1897	16.65	103.5	1933	38.95	110.5

[1] (172).

TABLE 32.—*Farm value per head of cattle and sheep in four western States, 1932–34*[1]

State	Cattle			Sheep		
	1932	1933	1934	1932	1933	1934
Idaho	$19.46	$15.86	$18.05	$3.22	$4.10	$4.86
Montana	20.57	17.19	18.28	2.97	4.12	4.88
Oregon	21.09	16.91	24.09	3.93	3.93	4.64
Washington	25.52	19.67	26.63	3.51	4.45	5.00

[1] Matson, Palmer, and Haight. Practical Livestock Operations and Credits. Farm Credit Administration, Twelfth District, Federal Intermediate Credit Bank Data. 11 pp. 1935. [Mimeographed.]

These changes in livestock prices are reflected perceptibly in the total capitalized valuation of an enterprise and materially modify the percentage of the investment chargeable to the herds. For example the difference in inventory value as between 1922 and 1928 for cattle as shown in table 31 would be an increase of 64 percent in the value of the herd. Table 32 illustrates this strikingly for even short periods. For example, inventory values in cattle decreased from 1932 to 1933 by 18 to 25 percent, whereas sheep inventories for the same period increased by approximately 33 percent. Saunderson and Vinke's studies (*121*) further illustrate this point. The total investment per head of Montana range sheep and the ewe value per head are estimated in table 33.

TABLE 33.—*Ratio of ewe value per head to total investment in lands, herds, etc., per head, Montana, 1890–1932*

Year	Total investment per head	Ewe value per head	Assumed land, improvement, etc., value per head	Ratio of ewe value to total investment
1890	$3.75	$2.50	$1.25	0.66
1895	2.95	1.50	1.45	.51
1900	4.20	2.85	1.45	.66
1905	4.95	3.50	1.45	.71
1910	5.60	4.15	1.45	.74
1915	8.00	5.00	3.00	.63
1920	25.00	10.25	14.75	.41
1925	22.00	11.50	20.50	.36
1930	30.00	7.00	23.00	.23
1931	25.00	5.00	20.00	.20
1932	20.00	3.50	16.50	.18

The difference between total investment and owe value as shown in column 3 of table 33 is an approximate index of the amount invested per animal in lands, improvements, and facilities. From this index figure it will be noted that investment per head for lands, improvements, and facilities is low and approximately constant up to 1910, with an index figure 1.45. In 1915, the index is about doubled, and from 1920 to 1930 the index rises sharply. From these indexes the conclusion may safely be drawn that the capital investment per unit head in lands, improvements, and facilities has steadily mounted reaching a high peak in 1930. The ratios in the last column represent an approximate ratio of the investment in the breeding herd to the total investment in the enterprise, and indicate that the investment in the breeding herd has steadily declined from 1890 to 1932. This basic relationship between the percentage invested in lands and the percentage invested in livestock is of utmost importance in determining final profits and also has played no small part in shaping range management practice—much of it of a character detrimental to the range.

Total investments illustrate the whole trend of overcapitalization, from a unit head investment of $3.75 in 1890 to a high of $32 in 1925 and a drop to no less than $20 in 1932.

From the standpoint of profits, the breeding herd, the basis of the salable crop, is of primary importance. Obviously, other things being equal, the producer who maintains the highest percentage of his capital investment in breeding stock will show the greatest returns. This fact is well illustrated by a number of studies. In Wyoming (*168*), "operators whose investment in cattle represented at least a third of their total investment were doing better financially than those operators who had less than one-third of their investment in cattle." In Utah (*103*), "profits tended to decrease as the percentage of total investment represented by cattle decreased. * * * That ranch tends strongly to be profitable which has 25 percent or more of its total investment in cattle, and 35 to 45 percent is still more profitable."

One of the great difficulties in maintaining this desirable ratio, favoring the highest relative investment in livestock, particularly when livestock valuation is high, is the scarcity and availability of reasonably priced range. Home-ranch and range-land prices have, during the past two decades, attained levels far beyond their possible earning capacity, and the stockman has thus been forced to invest far too much in high-priced land. Under these conditions, if he continues to run the number of livestock that ranch and range should support adequately under normal conditions, he will inevitably find it difficult to show a fair profit on his investment, or he may even go in the red. He then resorts to a very tempting alternative which may temporarily establish a normal balance between investments in lands and investments in livestock, namely, he overstocks the ranch and range. For a short period this may bring more income and probable profits, but, if so, it is at the expense of the production capacity of the land. It is a form of exploitation which inevitably leads to range depletion. When this process has gone far enough

he finds himself in a vicious circle. The depleted range, if stocking is not reduced, produces less pounds per animal or he is forced to buy more range or lease more feed. This again destroys the economic balance he must maintain between breeding herds, investments, and production possibilities.

Even for the stockman who leases range the same processes operate where exorbitant and fictitious ranch and range land values are competitively established. On many of the western outfits prohibitive charges for leasing range have been the direct cause of overstocking, as the only means of maintaining reasonable unit-carrying costs of herds. The stockman, never assured of renewal, proceeded under these conditions to "mine" the forage crop in one season.

All agriculture, as well as the livestock industry, has suffered severely from inflated land values, which become particularly burdensome when crops must be sold in a depressed market. High land capitalization is further complicated by the fact that much ranch and range lands were purchased on partial-payment plans during periods of inflation and payments had to be met during periods of depressed prices, thus presenting a double burden of high carrying costs.

To reduce high carrying costs of land when livestock prices are low overstocking is resorted to on the false assumption that losses may be reduced. In so doing losses may temporarily be averted or deferred, but finally the basic land resource may suffer to a degree where continuance of a sustained profitable enterprise is not possible even when good markets again prevail.

Inflated land values have thus increasingly put out of balance the percentage of the capital investment which should be carried in the herd, have reduced prospective profits, induced bad husbandry, and lastly, have been a major factor in overstocking and range depletion.

The Relation of Production Costs to Profits and Range Depletion

It is in many instances impossible to make a direct comparison of the data found in the available detailed cost-of-operation studies. Not always have the same common denominators been used; allowances are sometimes made for contributed labor and interest on investment, but it is difficult to so segregate these that safe comparisons can be drawn.

In a general way the items and amounts that enter into operating costs are reasonably well illustrated in information collected by the Federal Intermediate Credit Bank[20] as shown in tables 34 and 35. These represent data for 1934, a year of relative average high expense and low returns, and are reasonably representative for the 11 western States.

[20] See footnote to table 32, p. 196.

TABLE 34.—*Cost of grazing operation per unit head of sheep, 1934*

Expense items	Types of lambing practice			Types of operation			Size of operation		
	Early	Early to late	Late	Owner	Owner and lessee	Transient	Large	Medium	Small
Labor	$1.140	$1.168	$0.836	$1.10	$1.06	$0.72	$1.09	$1.02	$0.78
Feed and range	2.016	1.357	.798	1.62	1.41	1.28	1.48	.98	1.14
Carrying charges	3.082	3.089	2.313	2.73	2.68	2.46	2.83	2.71	2.80
Total costs	6.238	5.614	3.945	4.85	5.15	4.46	5.07	4.71	4.72
Detailed carrying charges:									
Supplies	.522	.851	.555	.53	.56	.59	.50	.57	.64
Taxes and interest	.737	.671	.631	.70	.71	.52	.64	.72	.65
Auto expense	.246	.355	.169	.32	.34	.23	.22	.20	.29
Personal and insurance	.240	.247	.190	.24	.26	.23	.26	.23	.23
Restocking (bucks, rams)	.064	.061	.040	.05	.04	.05	.04	.01	.11
Miscellaneous	.220	.235	.110	.17	.25	.14	.25	.18	.11
Loss and depreciation	.838	.900	.537	.83	.62	.70	.61	.60	.77

TABLE 35.—*Cost of operation per unit head of cattle, 1934*

Expense items	Large	Medium	Small	Average
Labor	$1.63	$1.47	$2.10	$1.80
Feed and range	1.67	1.86	3.25	1.97
Carrying charges	9.44	8.11	7.46	8.28
Total costs	12.14	10.94	12.21	12.09
Detailed carrying charges:				
Supplies	1.54	1.26	2.11	1.65
Taxes and interest	3.59	3.53	2.37	3.13
Auto expense	.53	.41	.95	.55
Personal and insurance	.96	.70	.15	.80
Restocking (bulls)	.73	.51	.08	.41
Miscellaneous	.16	.05	.38	.12
Loss	1.86	1.05	1.39	1.39

All the items that constitute the cost of production and which must be met ordinarily by current annual cash outlays can be grouped conveniently into three classes—labor, feed, and carrying charges. Of these, feed costs and that portion of the carrying charges directly related to the land, such as taxes, interest, or rentals for leased land, make up a substantial part of the total cost of operation.

The cost of feed and forage may become a controlling factor in profits and influence to a large extent the development of range practices. It is important, therefore, to consider how the stockman gets his feed, what it costs, and how land and range management affect the feed supply, profits, and the enterprise itself.

The western stockman obtains feed from owned or leased range lands, permitted use on national forests, free range on public domain, and by raising or purchasing supplemental feeds. As stated, the carrying costs of the commensurable lands which must produce the wild forage and supplemental crop feeds, together with the cash outlay for producing or buying feeds or for leasing range, make up a substantial part of the whole cost of production. If these total feed costs are inordinately out of line, profits diminish materially. Feed frequently makes or breaks the stockman.

Unfortunately, the stockman has never been quite sure of his feed sources. Even if he owns the land and has not abused it, there is no

certainty what the ranch or range may produce in crops or forage for any given season. The vicissitudes of climate as a factor in forage production have already been described. The forage crop may vary from year to year; it may be wiped out by a drought or lessened considerably in expected amount through a cycle of dry years.

The western stockman is just as much at the mercy of weather as any other crop farmer. Lack of rain, drying winds, low temperatures during growing seasons, all take their toll in forage production. Shortages in feed due to adverse climatic factors are in a measure largely unpredictable and uncontrollable. To meet these vagaries of climate, the prudent stockman, if he has the capital, must invest in reserve feed supplies and additional range to meet such emergencies. Otherwise he must meet the emergency in paying exorbitant prices for feed, or is forced to sell his stock far below the cost of production.

When a cycle of favorable climatic years comes, the general tendency has been to increase breeding stock to the maximum. If, with these conditions, there is also a rise in prices for stock, competition for range becomes active, land prices rise—whether for purchase or lease—and thus the coincidence of a favorable market and a good forage year may be vitiated by carrying costs of high-value land and high forage costs.

Under adverse climatic conditions, even with depressed livestock prices, the very shortage of feed induces a strong competitive market for feed and range. Good or bad forage years, the stockman unprovided with reserve feed has laid himself open, so far as feed or forage is concerned, to a high competitive market and a corresponding increase in cost of production.

These uncertainties as to availability of feed and its probable cost introduce a major factor of uncertainty and hazard in the entire enterprise. They lead the producer to gamble for large gains whenever the opportunity arises; and maximum stocking during good feed years is the most tempting gamble, generally leading to range exploitation. In time of drought the producer who has built up his operation by excessive stocking may find himself again in an acute situation, particularly as forage costs reach high levels. As stated by some observers (*187*), "judging from the history of the years 1886–87 and 1919–20, the occurrence of a very poor year or a succession of poor years usually means a crisis to many individual operators because of high operating expenses and great death losses among cattle." This is confirmed by another study,[21] which states: "One hard winter or one severe drought may cause a heavier loss in 1 year than has been gained in several years by heavy stocking."

The stockman tries to meet the severe financial stresses and strains that he is subjected to by reducing carrying costs per unit head. What are these possibilities for reduction in cost of production? Some carrying charges are almost immutably fixed, such as taxes and interest on indebtedness for land and stock. He may reduce labor costs, but these form but a fraction of the total expenditures. If he reduces labor too drastically, it may be at such a sacrifice in good

[21] Parr and Klemmedson. An Economic Study of the Costs and Methods of Range Cattle Production in North Central Texas. U. S. Dept. Agr., Bur. Agr. Econ. Prelim. Rept. 40 pp. 1925. [Mimeographed.]

care of the stock, losses from predators and poisonous plants, reduction in calf or lamb crop, and the poorer general condition and quality of the salable animals that these losses may be materially disproportionate to the gains made by decreased labor costs. He may reduce the amount of supplemental feed per animal, and here again it will be directly reflected in the condition of his herd. What he is likely to do as the easiest way out to reduce unit production cost per animal is to overstock his range.

The condition of the livestock, the percentage of lamb or calf crop, are readily detected, and the stockman is reasonably well-informed on these matters. He prizes his breeding herd as the important part of the production plant. His interest in the range is, on the contrary, less evident. In the desire to keep carrying costs per unit-head low, he may hold too many stock on the range in a bad year, figuring that the next year may be favorable and the range will revive. He overstocks in a good forage year because he is overenthusiastic about the range capacity by contrast with the poor year, and he also gambles that more good years must follow. The fact is forgotten or overlooked that the condition of the range is a major influence in the proper maintenance of the breeding herd and in the final increment of calf or lamb crop, which in the last analysis determines the ratio of income to cost of production. The effect of this is that on a very important part of his capital investment a process of attrition is initiated. This process frequently continues slowly, and is not perceptible to the owner or lessee of the range. He does not appreciate that it is cutting vitally into a part of his capital, just as important as the capital invested in the herd, and that ultimately it means an increase in the unit cost of production. Innumerable instances can be cited where land purchased on the basis of high grazing capacity, which might have been a good capital investment, because of abuse through overstocking was reduced to one-half or one-fifth of its original forage production and thus was converted into a poor investment and brought about unduly high unit-production costs. Such methods mean higher unit costs for forage, if stocks are reduced to the commensurate availability of forage; or, if the original number of stock is maintained, the reduction in weight, quality, and offspring will increase unit costs. And to this must also be added an annual depreciation charge because of the depleted values in the range.

If overstocking continues, the important forage plants slowly are reduced in number and some may even disappear. Pest plants and less desirable plants invade and immediately start their conquest of the range. If this overstocking should coincide with the prevalence of a dry cycle, not uncommon in the western range States, startlingly unfavorable changes become evident even to the most optimistic. Sheet and gulley erosion, disappearance of common perennial grasses, thin stands of annuals, closely cropped shrubs, increase in undesirable and poisonous plant species, disappearance of springs, and lowered water tables, are all signs that a range property has badly depreciated, and that one important leg of the capital structure in a given livestock enterprise has become shaky.

When this stage is reached this part of the capital structure (the range) requires restorative treatment. Restoration of former forage values is a costly process requiring labor and cash outlay. But the

first step in any positive curative process is the reduction or even total removal of stock. If depletion is not serious and is recognized early enough, reduction in numbers, more careful handling on the range, and care in preventing too early grazing may suffice and give nature an opportunity to heal the scars and renew vegetation. But depletion may reach a point where costly gully control, artificial reseeding, and grubbing of poisonous plants may be required, as well as reduction in numbers of stock grazed. Investments and improvements may be needed, such as development of new sources of water and fencing off the most seriously punished lands from all use. These costs may reach a figure of $5 per acre, an investment frequently more than the land can carry under private ownership. Whether the producer reduces the number of stock or makes further investments to restore the productivity of the range, the yearly carrying charges must be increased, and with it the unit cost of production.

Unfortunately the stockman is rarely ready to apply the stiff remedy of reduction of stocking, even when he recognizes that the range is going back, and rarely able to make the otherwise necessary protective investments. Again he is caught in a vicious cycle, his depleted range produces poorer stock, smaller yields in calves and lambs, and higher losses. He delays as long as he can the reduction in stock and so the situation grows worse, or if he resorts to the purchase of more land, this again increases his investment in lands out of proportion with the investments in breeding herds and creates a corresponding increase in unit cost of production.

Credit Facilities and Their Relation to Profits and Range Depletion

In the past the livestock producer depended for his credits on private banks, loan associations, insurance companies, and occasionally on commission men. Since the World War, Federal banking facilities have become available, such as the War Finance Corporation, and more recently the Farm Credit Administration.

Like all agriculture, the livestock industry has suffered in the past from lack of favorable credit facilities. Loans carried high interest rates and were extended only for short-term periods. With his larger investments, the individual stockman has found the usual credit terms even more onerous than has the crop farmer. Short-term loans might suffice for current operations, incurred indebtedness, and to carry over livestock held for a more favorable market. But if he desires to build up his herd, purchase more land, improve facilities, or construct essential improvements on the range, long-term reasonably low interest-bearing loans are necessary. Excepting for land purchases, credits in the past for other needs have carried high interest rates, and rates of 9 to 10 percent were common. A study made by the Oregon Agricultural College (*105*) illustrates this difficulty. They found in 1925 that—

> There is a considerable variation in the interest rate * * * It is, of course, a fact that many of the banks charge 9 percent and 10 percent, and it is also a fact that the cattle-loan companies charge 9 percent to 9½ percent or even 10 percent interest. * * * It is unfortunately true, however, that the cattle and sheep industries are at the present time charged the highest rates of interest known in the commercial world.

Under these conditions it is not surprising that many improvements needed to make more advantageous use of the forage were not undertaken and the range frequently suffered because of it.

For a long period of time, banks, cattle-loan associations, and, more recently, even Federal banking agencies have based their loans largely on the number of livestock owned by the borrower, without much consideration as to other assets, availability of feed, or condition of the livestock. Some banks have refused to recognize that range land had any loan value. This trend has led indirectly to building up or holding more livestock than the range could carry so as to build up collateral for loans. Obviously, if the loan were made with adequate restrictions safeguarding the range, in the long run loans would be better secured, to the advantage of borrower and lender alike. Even the Federal banking agencies have failed to recognize the full import and need for care of the collateral existing in the range. In more recent loans through the Farm Credit Administration the grazing privileges on a national forest held by the borrower has been considered as an asset and valued as collateral.

On the face of it this appears to give value to range even if not owned. This practice has been based on the theory that a national-forest permit is a negotiable asset, is revocable only for serious cause, and transferable under certain prescribed conditions. Such Federal loan agencies have also requested, in order to add security to the loan, a guarantee that the Forest Service would not make reductions in the number of stock for permits carrying loans. The Forest Service, among other reasons, has insisted and contends that to guarantee no reductions might defeat the integrity of the assets themselves if and when reductions in number of stock were necessary to safeguard the range. Dry cycles, producing adverse conditions and need for range rehabilitation may necessitate large and immediate reductions in livestock grazed. Here again the fact that the production plant of the grazier consists of herds and range has been lost sight of. In the long run the best way to protect the loan and insure sustained profits to the borrower would be to insist that the range be given proper care, whether owned or leased.

No continuous record of indebtedness carried per unit animal extending for a long period and covering a single region is available. The general evidence indicates that there was a steady but small increase in indebtedness per animal from 1880 to 1910 and that thereafter the indebtedness increased sharply. One reason for mounting indebtedness is traceable in the extension of old loans which were not reduced in 20 years.

Some examples of indebtedness may be given to show the amounts carried by the producer. In two studies made in Colorado (*24*, *25*) in 1922–25 a total average indebtedness of $32,446 for 800 head of stock, or $40 per head, is reported in one instance, and in another a total average indebtedness of $33,200 against 1,016 cows, or $33 per cow. A study made in 1926 in New Mexico (*174*) reports an average total indebtedness of $27,552 against 1,224 animal units per ranch, or $23 per animal unit.

Indebtednesses in the northern Great Plains region in 1924 are given in table 36 (*187*).

TABLE 36.—*Indebtedness per ranch and per head of stock in the northern Great Plains region, 1924*

Ranch	Stock per ranch	Cows per ranch	Indebtedness per ranch	Indebtedness per head of stock	Indebtedness for cattle only
	Number	*Number*	*Dollars*	*Dollars*	*Dollars*
A	85	36	3,920	46	13
B	139	72	3,300	23	12
C	260	141	6,033	27	13
D	670	265	17,681	26	17
E	1,734	723	42,611	25	19

In this same study the average inventory value per head was placed at $39.71. Of the total indebtedness per head of livestock on the ranch it will be seen that the chattel mortgage forms but a small part of the total.

The stockman started with small initial investments in lands and proceeded through a series of years to build up his herds to high numbers without encumbering himself with indebtedness. True, in severe years when losses both in calf and lamb crops and in breeding stock were abnormally high, he had to resort to whatever credit facilities were available to get a fresh start. Credit under such conditions was extended at almost usurious rates.

The trend of easy credits, high interest rates, and their effect on the profits of the stockman is well illustrated in certain findings in Oregon (*106*):

> Inadequate finances often lower the profits, * * * partly because the management is in the hands of the bank or loan company. * * * If the owner has an equity of 50 percent or more in the entire plant * * * he should be able to borrow the remainder at an interest rate of not over 7 percent * * * if his equity is much less than 50 percent, he will probably have to pay 9- to 10-percent interest. * * * A 75-percent equity in a one-band outfit is much better than a 25-percent equity in three or four bands.

A significant trend in finance and banking has been in operation in the past 20 years and has contributed to increase average indebtedness. As working capital in all banks accumulated, western bankers looking for outlets encouraged expansion in the livestock industry and made credits readily available. Loans were made for the purchase of lands and stock, and frequently to many persons unqualified for the undertaking. Stockmen could not resist the temptation to expand under such easy credits, even at high-interest rates. Frequently this led to the building up of herds beyond the safe capacity of the available range. In contrast to the easy credits of good times, credits were restricted during depressions when money was most needed. Insofar as the welfare of the range is concerned, the inflexibility of credit facilities was one serious cause in keeping the number of stock out of balance with availability of range and was a contributing cause of overstocking and range depletion.

THE BANKERS' VIEWPOINT

Bankers who specialize in livestock loans developed certain points of view that reflected the attitude of the stockmen themselves. Some of the abuses in the form of inflexibility of credits, short-term char-

acter of loans, and high interest rates were the result of causes outside the immediate control of either the bankers or the stockmen. The livestock business grew up in the West as a highly speculative venture; and having built up such a reputation, it had to pay exacting penalties when it was in the market for money. The crop the grazier produces takes a long time to mature. The amount and quality of the salable crop may shrink through unpredictable losses, and the final sale price may, from day to day, month to month, and year to year, have a wide spread, frequently falling below the cost of production. On the basis of these conditions, the banker has built up a system of livestock loans. His has been a short-term point of view, with inevitable high rates and inflexibility of credit. It really has amounted to a system of loans secured, not by a production plant, consisting of ranch, range, and livestock capable of producing an annual salable crop, but by a chattel mortgage on livestock. Little consideration has been given until recently to the possibilities of building up an industry on a sustained yield management concept, wherein the whole production plant, feed, forage, and stock are kept in balance and the vagaries of market and climate are partially counterbalanced by reserves in feed and credits.

The banks and loan associations have done little in the past to discourage or eliminate bad husbandry. They have done little to encourage management practices, and yet these are the real basis of profits in a livestock enterprise, the true measure of the security of the collateral, and the safety of the loan itself. At best it is difficult to ascertain the real assets of a livestock producer. In some instances loans have been made without even a count of the stock on the range and no appraisal of the value of the stock, the range, improvements, or capacity of the borrower as a livestock manager. Bankers have often forced liquidation of well-bred breeding stock on depressed markets, further lowering general prices and with practically no returns to the producer. Good business would often have dictated further loans to buy additional feed to carry the breeding herd over the depression. At other times banks have enforced holding stock until more favorable markets without supplying funds to buy adequate feed, leaving the producer one alternative, that of keeping more livestock than the range could safely carry, and with it the inevitable sequence, overstocking, range exploitation, and range depletion.

Such myopic banking policies have not only contributed to the disruption of the livestock business but have also caused the closing of many banks that dealt in livestock loans in the West.

There are, however, many signs of a favorable change and through the facilities of the Farm Credit Administration many of these abuses can be checked. Among the more important provisions of this new governmental agency which may go a long way to stabilize the industry and ultimately safeguard the range itself are the following:

1. Overexpansion discouraged (*a*) by requiring a sound ratio between all parts of the production plant; (*b*) by requiring reasonable margins in security offered as collateral.

2. Longer periods of loans at much lower rates than were ever before available to the industry as a whole.

3. Adequate showing of range and feed for the number of stock to be handled.
4. An actual inventory, not only of stock, but range, feed, facilities, etc.
5. A check on the moral risk of the borrower with the motto—"The eyes of the master make fat cattle."

Marketing and Its Relationship to Profits and Range Depletion

The availability of favorable markets, with some degree of stability in prices for reasonable periods, is axiomatically the foundation for any self-sustained industry. The livestock producer has on the contrary never been sure of reasonably favorable market conditions where a stable price range was assured for any short period.

As might be expected, the demand for the products of the western range increased with the growth of the Nation, and its outlets to markets have been facilitated tremendously with the extension of the western links of the American railroad system. Modern livestock marketing is an outgrowth of the railroad and the cold-storage plant which has made possible the central stockyard systems and packing plant. From very simple marketing systems a complicated machinery of distribution has grown up between the ultimate consumer and livestock producer.

At present, the producer has these means of disposal of his produce—the local butcher, a local buyer, individual shipment on consignment in carload lots to a commission agent, and disposal through cooperative shipping associations. The local buyer may be an individual speculator or represent a commission agent at some central market or a local butchering concern.

The bulk of the salable livestock produced in the western range States must be marketed at central stockyards and packing points; local markets absorb but a small percentage of the total. The chief market is therefore at some distant point.

Whichever method of marketing is used, the ultimate price the producer may receive is determined by forces entirely out of his control, which may have no relation to the cost of actual production. As one stockman has very aptly stated:

> It is fundamentally unsound to expect reasonable returns if a perishable product must be taken 1,000 miles to the appraisal of a fluctuating market from which there is no retreat.

Once the stock is on its way to market, the seller is entirely at the mercy of the buyer.

Price fluctuation is well illustrated in the average prices at the Chicago market for 5 years given in table 37.

But prices fluctuate even in shorter periods of time. The periodic variations in prices illustrated in table 38 show the prices paid for lamb and beef steers by periodic averages for 1930–34 at the Chicago market. Thus we find a wide fluctuation both in yearly and even monthly prices.

TABLE 37.—*Average prices per 100 pounds for beef and lambs at the Chicago market, 1930–34* [1]

Year	Beef steers, 1,100 to 1,300 pounds, Good	Lambs, 90 pounds down, Good, and Choice
1930	$11.81	$9.40
1931	8.92	7.77
1932	7.46	6.11
1933	5.69	6.63
1934	7.31	7.32

[1] Bureau of Agricultural Economics statistics (*188*) and mimeographed reports for 1930–33.

TABLE 38.—*Four monthly prices* [1] *for years 1930–34 to illustrate variation in monthly prices throughout year at Chicago market* [2]

[Sources of data: See footnote to table 37]

Month	1930		1931		1932		1933		1934	
	Beef	Lambs	Beef	Lambs	Beef	Lambs	Beef	Lambs	Beef	Lambs
January	$12.77	$12.20	$11.31	$8.71	$8.57	$6.16	$5.15	$4.01	$5.63	$5.33
April	13.17	6.77	8.72	9.35	7.31	6.91	5.32	5.43	6.90	9.49
July	9.95	10.13	7.36	7.67	6.16	6.27	6.15	7.67	7.74	7.32
October	10.39	8.05	8.94	6.36	7.47	5.30	5.55	6.74	7.65	6.49

[1] Beef, 1,100 to 1,300 pounds, Good; lambs, 90 pounds, Good and Choice.
[2] Based on means of daily range of quotations.

What the producer ultimately receives, of course, depends on the selling price, influenced among other things by the class of stock he raises, the freight charges to market, and all the other miscellaneous handling costs from the shipping point to the slaughterhouse. As between regions, the market factor includes the freight differentials, the general class of stock produced in the region, and the season of marketing.

Table 39 (*152*) is a 5-year average (1930–34) for prices received by producers, as of January 15 of each year.

TABLE 39.—*Five-year average of prices received by producer per 100 pounds*

State	Beef	Lambs	State	Beef	Lambs
Montana	$4.96	$5.64	New Mexico	$4.89	$5.82
Idaho	4.52	5.51	Utah	4.92	5.79
Washington	5.10	5.74	Nevada	5.00	6.28
Oregon	5.49	5.43	Colorado	5.44	6.24
California	5.66	6.70	Wyoming	5.27	6.35
Arizona	5.00	6.57			

The maximum regional differences for beef in this period is $1.14 per 100 pounds as between the California-Nevada price and that for Idaho, or about $14 per animal for a 1,200-pound steer. The maximum regional differences in lambs is $1.44 per 100 pounds as between Arizona and Oregon, or about $1 per animal. These major regional differences in final price received by producer on a parity basis of profits per animal can only be compensated for by corresponding reductions in actual costs of production.

The inherent differences in the prices the producer may receive for the same class of stock from region to region cannot be entirely eliminated. But more serious problems confront the livestock producer in attempting to secure a fair return for his product.

The uncertainty of price and lack of a free competitive market was early recognized. The exhaustive report of the Federal Trade Commission (*166*) covers this matter thoroughly. It shows that, up to 1919, five large packers held complete control of the market.

The Packers and Stockyard Act of 1921, as a result of this inquiry, sought to regulate the business of the packers by preventing unfair discriminatory or deceptive practices. The chief evil it particularly aimed to curb as relating to the livestock producer, was the monopoly the packers enjoyed and which enabled them unduly and arbitrarily to lower prices to the shipper. It attempted to secure a free and unburdened flow of livestock from the West through the stockyards and slaughtering centers. In 1926, and again in 1935, the Packers and Stockyard Act of 1921 was further amended to eliminate other marketing abuses.[22]

The fluctuating in and uncertainty of prices has been the hazardous factor which in no small part has contributed to the instability of the livestock enterprise. But even under the most favorable conditions of open competition, price fluctuations from year to year may reach wide extremes. This may become particularly oppressive, because the producer has to make his cash outlays many years in advance of the marketing of his final product. If the gestation period is counted it takes, under very favorable practices, a year to produce a lamb for market, a year and a half for a baby beef, and for the usual market steer from western ranges at least 2½ years.

Even the growth of cold-storage facilities, which makes possible the evening out of supplies for consumption, does not show the expected stabilization of prices to the producer. The producer is in a constant quandary what his product may bring. It is particularly disturbing because it not only affects his current salable produce but the produce which will reach market 2 years hence and for which investment outlays are being currently incurred.

Ordinarily the producer is not a free agent to hold back sales awaiting a rising and more favorable market. Frequently, in order to meet current expenses, he must sell his stock in a most unfavorable market. If he does hold on, he often does so at the expense of the range because the hold-over stock are surpluses which ordinarily should have been moved.

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[22] In the *Stafford* v. *Wallace* case, no. 687691, an appeal of the enforcement of the Packers and Stockyard Act of 1921, Mr. Chief Justice Taft in rendering opinion of the Court stated: "The chief evil feared is the monopoly of the packers, enabling them unduly and arbitrarily to lower prices to the shipper who sells and unduly and arbitrarily to increase the price to the consumer who buys. Another evil which it sought to provide against by the act was exorbitant charges, duplication of commissions, deceptive practices in respect to prices, all made possible by collusion between the stockyards management and the commission men on the one hand, and the packers and dealers on the other. * * * The shipper whose livestock are being cared for and sold in the stockyards market is ordinarily not present at the sale, but is far away in the West. He is wholly dependent on the commission men." The Chief Justice in quoting the *Swift & Co.* v. *United States* (196 U. S. 375), states: "The *Swift* case presented to this Court the sufficiency of a bill of equity brought against substantially the same packing firms as those against whom this legislation is directed, charging them as a combination of dominant proportion of the dealers in fresh meat throughout the United States not to bid against each other in the livestock markets of the different States, to bid up prices for a few days in order to induce the cattlemen to send their stock to the stockyards, to fix prices at which they would sell, and to that end to restrict shipments of meat when necessary * * * and all this in a conspiracy and single connected scheme to monopolize the supply and distribution of fresh meats throughout the United States."

Depressed or glutted markets and slack sales often are the direct cause of overstocking. With restricted credits and short reserves in hay and other supplemental feeds that result from previous overstocking, the only alternative has appeared to be to further stock the ranges, owned or leased, far beyond their capacity. The aftermath of enforced hold-over has been range depletion. In holding down operating expenditures because of unfavorable markets and low prices, there is little latitude for the producer. His fixed costs remain constant, feed may even be proportionally higher than usual. He resorts to overstocking and hence range depletion as the easiest way out.

Profits

In comparison with other agricultural crop farming, the livestock industry, over extended periods, has experienced as great or even greater fluctuations in returns on investments. Under the most favorable conditions profits have been exceedingly high. This has attracted new capital, induced overexpansion, and brought the evils that generally follow in the wake of overproduction.

One major control on profits as between regions is the nearness to market—as indicated, this differential may mean as much as $14 per steer and $1 per lamb. To overcome this handicap the unfavorable regions must possess other advantages, either in cheaper lands, cheaper forage, more favorable climate, or cheaper labor.

Another control is the capital-investment relationship as between lands, herds, and improvements, and the unit size of operation. The breeding herds must be at a safe maximum that the range can support without damaging it and that will still leave reserve feed for critical years.

Still another factor is the size of the unit. This is well illustrated by data secured in many studies. Highest net returns in Utah (*103*) were reached by outfits having about 370 cattle. Records compiled by the Intermediate Credit Bank, twelfth district,[32] in 1934 on 3,520,000 cattle show greatest profit on outfits of 360 to 580 head. In Montana[33] 400 to 500 head of cattle appeared to be the size of operation under which it was possible to approach maximum efficiency; and another estimate (*120*) stated that net income from 100 head was $5, from 200 head $8, from 400 head $12, and that above 400 the net income declined until the figure for 900 head was $9.

For sheep the same general law of economic size applies, varying by regions. Utah figures (*46*) for size of outfits and percent of return are:

Sheep:	Percent return
230 to 1,000	9.0
1,001 to 2,000	13.8
2,001 to 3,000	17.8
Over 3,000	13.6

Records compiled by Intermediate Credit Bank, twelfth district,[32] in 1934 for over 9 million sheep show losses in cents per head as follows:

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[32] See footnote to table 32, p. 195.

[33] Saunderson, M. H. Some Materials Relating to Livestock and Land Valuation. Mont. Agr. Expt. Sta., Dept. Agr. Econ. 28 pp., illus. 1935. [Mimeographed.]

[32] See footnote to table 32, p. 196.

Outfit:	Costs
More than 3 bands	73
2 to 3 bands	73
1 band or less	66

In Wyoming (*169*), in 1925, ranches having between 7,001 and 8,000 ewes had a $9.49 return; above this and below, progressively smaller returns. The smallest returns were $2.64 for outfits of 1,000 and less and $2.68 for outfits with 9,000 and more. In Montana (*121*) it was found that from the standpoint of production organization the point of maximum efficiency in size could be realized at 3,600 to 4,500 ewes.

The hazardous features of the enterprises which affect profits and induce malpractices injurious to the range have already been reviewed. The vicissitudes of climate may wipe out all profits for many years unless adequate reserve feed is maintained. Poisonous plants, animal diseases, predators, all take a toll that in bad years, on depleted range, may go beyond 10 percent of the total herd. Irregular prices, enforced hold-over, relatively high fixed costs, all affect profits adversely.

In the final analysis profits for the man in the straight livestock business without other sources of income will depend on:

1. A well-balanced outfit, as between capital investment in lands, improvements, and herds.
2. A proper size unit.
3. A carefully managed range with sufficient reserves in feed.
4. A stabilized market.
5. Reasonably long-term credit facilities.
6. Sound managerial and business skill.

Key Financial Problems

Many causes can be assigned for what appears to be the needless exploitation and depletion of our western ranges, but underlying all of these are certain financial handicaps which influence markedly and sometimes exclusively range practices and husbandry and are detrimental to the maintenance of the forage and the soil which produces it. Sometimes initial financial difficulties start abuses on the range; often abuses once started bring the stockman into further financial difficulties. The key financial problems, which with the passing of time have been persistently acute, have influenced exploitation, and often have greatly aggravated the results of poor husbandry, can be traced to uncontrolled disadvantageous markets, uncertain and onerous credit facilities, and high carrying costs of land.

Markets

The most disturbing factor of the livestock industry has been the uncertainty and lack of stability of its markets. Essentially this is a common problem of all agriculture and is national in character and in scope. The ordinary workings of supply and demand as a reasonably stabilizing force have not functioned. The loss of Old World markets, fluctuating changes in per-capita meat consumption at home, the abnormal peak demands during the Great War, all have merely accentuated previously existing disturbing factors.

Without assurances of reasonably steady markets, no industry can build soundly, and when it takes 2 to 3 years to produce a salable crop the consequences of an unstable market may be utter ruin.

The livestock producer has for many years been at the mercy of the packer and processor. Regardless of supply and demand, prices were set by a controlling group and in no relation to the cost of production. Some of these abuses have been mitigated by Federal and State laws, but essentially price is not fixed by the producer but is still controlled by outside forces. High freight rates and unfavorable differentials for some regions have placed further financial difficulties in the way of assuring a fair return to the producer. Inadequate marketing facilities and lack of control in supply and demand are still matters to be solved. There is promise that through cooperative marketing and agricultural-adjustment programs stabilization and fair prices may be attained.

CREDITS

Another financial difficulty of national character in the past has been the lack of adequate facilities for credits. The essential weakness in the credit system has been its assumption that the livestock enterprise was a gamble and a venturesome business, and its consequent extension only of short-term credits at high interest. This credit policy in no small measure contributed to mismanaged range. The unsound basis for loans, which ignored the care of the range and considered the number of stock as the basis for collateral, the easy markets during prosperous times, and restricted credits during depressed markets, have not been conducive to far-sighted plans for range management but rather encouraged liquidation of profits out of the range itself.

ERRONEOUS FINANCIAL PHILOSOPHY

The practices of the "free range" days laid too much emphasis on placing all the capital investments in livestock without regard to required investments in lands. The pioneer days of the open range constituted, as reported elsewhere, a period when the wealth of the stockman was measured by the total number of livestock he owned. His home ranch and improvements made up but a small portion of his total investment. As long as he could keep competitors off the virgin range, his task was merely the handling of his stock. Good years brought him big profits and bad years sometimes wiped him out. The predominant incentive of the open free range was the desire to increase stock ownership to the maximum. Even when competition for the open range became acute and some attempts at apportioning areas between the graziers was voluntarily initiated, the desire to maintain the largest possible herds persisted.

To secure a more permanent foothold, the more farseeing and prudent, through purchase, accumulated lands within or adjacent to the publicly open ranges. There was never, however, any sense of individual security that the open range used would not be encroached upon. This led to many a bitter range strife—particularly between cattlemen and sheepmen. While the industry suffered in these vicious struggles, the range, the basic resource for their indus-

try, suffered even more acutely and permanently. In many places, the open public range was "eaten or trampled into the ground" in this competitive strife, and—still worse—this range exploitation persisted on the public domain and likewise on privately owned or leased ranges held in single ownership.

A clear understanding that the condition of the range reflects the solvency and opportunity for profits of the livestock enterprise is not universally accepted.

HIGH LAND VALUES

Unsound expansion by operators in lands and stock have reflected the attitude of a new pioneer country, where superexpansion overrides a slower, but surer and sounder planned economy. The urge to secure a foothold on the range, and then control, brought the inevitable rise in land prices beyond anything that any husbandry could long support. High prices for poor or mediocre range lands was just another straw on an already overloaded camel's back. In the wake of expansion and high land prices came also the inevitable rise in the tax base and increased taxes. These encouraged the building up of excessive local governmental service which could not be permanently sustained. When a break in the flow of taxes came, tax delinquency brought complete break-down of local governmental functions even below the margin that a rural American community should have.

These financial problems all induced exploitation and short-term points of view regarding the ranch and range, and with these came depletion of the valuable natural resource, the foundation for a profitable and enduring livestock business.

UNSUITABLE LAND POLICY

By LYLE F. WATTS, Director, Northern Rocky Mountain Forest and Range Experiment Station

INTRODUCTION

The lack of constructive national land policy designed to fit the semiarid and mountain grazing lands of the West has been a major factor in the depletion of our once great range forage resource. The belief in universal private ownership of land, the application to such a region of land laws designed to fit humid conditions, the failure to classify lands according to their highest use, and interpretation and administration of the statutes all played a definite part. The adverse effects of our past land policy on the ownership pattern of range lands and its influence on forage depletion are matters for national concern.

The range country, as defined elsewhere, roughly includes all of the usable range lands west of the line which divides the tall-grass prairies from the short-grass plains. While there is much country east of this line best suited for range use and also much admirable crop land farther west, it is generally true that only in the most favored locations is the low annual precipitation of the semiarid West sufficient without irrigation for permanent, successful crop agriculture.

A brief résumé of the purpose back of the acquisition by the United States of this immense area may provide a background which will aid in understanding the causes for the mistreatment to which it has been subjected. During the period of acquisition, the first half of the nineteenth century, most of that great stretch of country from Omaha west to the Rocky Mountains was mapped as the Great American Desert.

> Here was a country, stretching all the way from the Red River to the Canadian boundary, which seemed destined by a kind Providence to provide a permanent home for the Indian. Here he might live undisturbed, freed from the pressure of the westward-moving pioneer, who would never • • • settle in that semiarid, treeless country where all efforts at agriculture must surely fail. • • • Beyond the Missouri could never be utilized by white men, but must ever remain the home of the wild tribes who roamed over those frightful and terrifying wastes. (98.)

Why, then, did we acquire this country?

The Louisiana Purchase of 1803 (fig. 60) was made because President Jefferson was convinced that we must control the port of New Orleans, then in French possession (74). Free access to the Gulf was essential to the development and future prosperity of the Ohio and lower Mississippi Valleys. He sent Monroe to join Livingston, our Ambassador to France, to bargain for the port and Napoleon refused to relinquish the French claim unless he could include the

entire French possessions on the Mississippi River Drainage. Much as they disliked to do so, our envoys acceded to his demands and that immense area was added to the public domain (*5*).

Texas, a sovereign State which had recently won its freedom from Mexico, was annexed in 1845. Settlement had been partly from Mexico, but mainly through the efforts of an American colonizer, Austin, who had been granted concessions from the Mexican Government (*87*). Through Austin's influence a large number of frontiersmen from the United States had taken up land and settled in the east portion. In self-protection against Mexico, they petitioned for admission to the Union, and after a political battle they were permitted to join. However, that immense area of predominantly

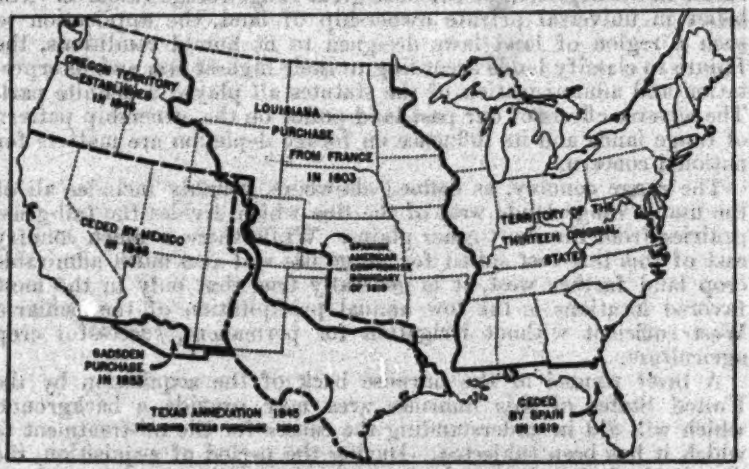

FIGURE 60.—BUILDING OF THE WESTERN RANGE LANDS.

The future range lands of the United States were acquired in huge tracts within a space of 50 years, with little if any thought of the wealth in forage and other products and services that they comprised. Areas in millions of acres, from General Land Office figures are: Louisiana Purchase, 529.9; Texas Annexation (independent of the Texas Purchase of 1850), 170.2; Oregon Territory, 183.4; Texas Purchase, 78.9; Mexican Cession, 338.7; Gadsden Purchase, 19.0.

range lands was considered so worthless that we refused to assume their public debt of $10,000,000, and in lieu they retained sovereignty over all land within their borders (*146*). Final settlement of the boundary claims of Texas was effected in 1850, when part of the area claimed by Texas, including part of New Mexico, Oklahoma, Colorado, Wyoming, and Kansas, was acquired by purchase. Thus there has been no Federal public domain within the present boundary of the State of Texas.

The Oregon Territory was acquired in 1846, primarily because of the flourishing fur trade which had been built up largely by John Astor. This pioneer industry was so important that in spite of objections we again included much additional land which was then believed to be worthless. The great region acquired from Mexico in

1848 was wanted, partly because of agricultural or range values, but more because we could foresee the need for the Golden Gate Harbor and the Southern California ports. The Gadsden Purchase of 1853 was made primarily to provide an all-American route for the Southern Pacific Railroad (*64*). Thus, range forage values seem to have played little part and even not to have been visualized during the period of acquisition.

The general excellence of the forage cover over the greater part of the range country when the white man came in has been fully described. Briefly, the 848 million acres which constituted the virgin range supported close to its climax vegetation. Yet, within a single life span the greater part of this resource was destined to serious depletion. Much of the finest was to be denuded by the plow in an attempt at cropping lands suited only for grass. Truly, we have gone a long way to establish in fact the "Great American Desert" so familiar on the maps of the Oregon and Santa Fe Trail days.

The Period of Disposal

The disposal of western range lands antedates the acquisition of the West by our Government. The system followed in Texas and the Southwest is of special significance.

Texas, the Gadsden Purchase, and the Mexican annexation were all originally under Spanish ownership. Thus the Spanish philosophy of land colonization was established over a very large area prior to acquisition. In parts of Texas, New Mexico, and California the beginnings of a landed aristocracy were well established. Army officers, priests, personal friends of the ruling group, and adventurers anxious to settle the new country, were favored by grants of land. The civilization thus started, perhaps a remnant of the old feudal system in Spain, was designed to perpetuate a landed aristocracy and a lower caste to which land ownership was denied. Even yet our southwestern range country exhibits a tendency toward very large outfits to which is attached a peon type of existence.

Exact records of the Spanish and Mexican land grants in most instances have not been preserved. It is known that certain grants date back as far as 1731 (*87*) in Texas[*] and 1773 in California. It is probable that commitments of more or less legal nature were made long before those dates. The period between the passage of the Mexican land law of 1824 and acquisition of the area by the United States, however, accounts for the great majority of land which passed to private ownership by this method.

The various treaties of acquisition recognized the legality of land titles secured by prior grants. However, actual surveys of the land were made in relatively few cases. Claims to title frequently overlapped, or were possessed by more than one individual. Evidence of legal title often was lacking. Thus for many years, in the General Land Office and in the various courts, settlement of land claims originating during Spanish or Mexican sovereignty was a major function. The work of the Private Court of Claims, created in 1891

[*] The Texas grants are further discussed on p. 230.

primarily to facilitate settlement of land claims originating out of the Mexican Cession and the Gadsden Purchase, was completed in 1894 (*74*). The best available information indicates that there were more than 1,100 valid grants in California, New Mexico, and Arizona covering an area of more than 19 million acres.

Despite the fact that the average size of these grants was more than 17,000 acres and many were very much larger, most of those which are still used as range are in no better condition than the average of privately owned range lands. Here and there an outfit has realized the need for protecting the forage resource, but more often the ranges have been as seriously overstocked and as badly abused as on other private lands.

In contrast to the landed-aristocracy philosophy back of the Spanish and Mexican Land Grants, the public-land policy of the United States has been based on the democratic philosophy that all citizens should have an equal right to share in our land disposal. Small units only of sufficient size to support one family have been the objective. That the plan was successful in the humid agricultural region of the East can hardly be questioned. Had our range-land disposal legislation been so drawn and interpreted as truly to support this principle, it is possible that much less of our range land would have been so seriously depleted.

It is not the purpose of this report to trace through all of the land legislation of this country. There have been approximately 5,000 laws so classified (*161*). Certain laws or groups of laws have, however, had such an important bearing on range depletion that some special consideration of them seems essential.

THE HOMESTEAD LAWS

A land policy for the United States was first formulated by Alexander Hamilton, who believed that the public lands, if sold in small tracts to settlers, would furnish a very great source of revenue for the Government. Although emphasis in the early land ordinances was placed on the revenue feature (*154, p. 637*) there was very general recognition that the price must be kept sufficiently low as to be no hindrance to rapid colonization. Revenue, as a major factor in land disposal, survived for only a short period, but the belief that all lands should pass to private ownership in small tracts became firmly fixed (*74*). Laws designed to pass title direct to the settler were made less restrictive with each change.

The basic homestead law was passed in 1862 prior to the settlement of the semiarid range country west of Omaha, which was still "the Indian country." To be sure gold had been discovered in California, Montana, Idaho, and Colorado, and a flourishing agriculture was growing up in the valleys around these camps. The missions throughout the West had established themselves primarily on a basis of irrigated crop agriculture and livestock husbandry. Yet settlements were few and far between and the hardships of the Oregon and Santa Fe Trails were too real to encourage any thought of wholesale settlement. And then came the cattle.

Herds, as discussed in another section, built up around the demand for beef in the camps and for oxen to replace worn-out animals in the immigrant trains, expanded and made their owners independent. Texas cattlemen, without a market for their surplus stock after the Civil War, discovered the possibility of trailing to better ranges to the north for fattening. In the span of a few years almost the entire West was explored and stocked—overstocked—with cattle.

Many of the ranches experimented with crop raising around headquarters, mainly to winter the saddle stock and a few milch cows. Gardens were grown. Far-sighted stockmen soon realized that effective control of their range was tied in with control of the available stock water. Legal possession was essential to permanence in the right to use such key tracts. The 160-acre homestead law was the best way out.

Even though one man could acquire only 160 acres under this law, it was simple enough and not too questionable morally, to have a cow hand file and prove up on another key tract while working for the outfit. If he slept in the shack or sodhouse once in a while, had an old stove and some tin dishes and left a worn-out shirt hanging on a nail, it certainly was his home. There were plenty of cow punchers and plenty of others who were glad to make a few dollars by proving up on a claim. Then someone discovered that he had a key tract and no legal obligation to transfer the title which he got from the Government. So he "upped the price" and made a real stake. Another, more ambitious, decided that with his homestead, which included the only water for miles, he was a potential cowman and bought a few head of cattle. A new outfit was in the livestock business. Thus the principle of passing title to a sufficient area to support a family was never applied in the range country even from the beginning of settlement.

Gradually the news spread that there was opportunity in the Plains country and the rush of homesteaders began. That the land was ill suited to crop agriculture and that 160 acres would not support a family did not worry the settlers and apparently did not influence the administration of the law. Data segregating from the rest of the United States the homestead history of the range States are not available. However, the bulk of the lands in the tall-grass prairies and eastward had passed to private ownership before 1870. Thus table 40 and figure 61 give a fair indication of the rate of homesteading in the semiarid West. The phenomenal increase in acreage patented in the period beginning in 1913 was due to a liberalization of the law which permitted proof to be made after 21 months of residence, instead of after 5 years. This was known as the 3-year homestead law of 1912.

TABLE 40.—*Final homestead entries from passage of act to June 30, 1935*[1] *(commuted homesteads not included)*

Fiscal year	Number of entries	Area, acres	Fiscal year	Number of entries	Area, acres
1868	2,772	345,088	1902	31,627	4,943,748
1869	3,065	504,303	1903	26,373	3,870,044
1870	4,041	619,729	1904	23,363	3,232,717
1871	5,067	828,169	1905	24,631	3,419,327
1872	5,917	707,410	1906	25,646	3,936,749
1873	10,811	1,226,981	1907	28,403	3,740,505
1874	14,129	1,695,763	1908	29,086	4,242,711
1875	18,268	2,008,586	1909	25,510	3,600,407
1876	22,580	2,480,853	1910	28,283	3,705,963
1877	19,000	2,407,328	1911	28,908	4,620,197
1878	23,420	3,003,981	1912	34,836	4,905,060
1879	17,301	3,070,842	1913	53,253	10,009,385
1880	15,441	1,898,238	1914	48,724	9,391,121
1881	15,977	1,928,206	1915	37,343	7,180,962
1882	17,174	2,219,454	1916	37,988	7,275,251
1883	18,508	2,804,415	1917	43,727	8,407,300
1884	21,843	3,045,879	1918	41,319	8,284,428
1885	22,891	3,052,670	1919	22,833	4,524,760
1886	19,358	2,662,332	1920	20,774	3,873,606
1887	19,998	2,742,057	1921	35,889	7,725,749
1888	22,413	3,175,401	1922	30,919	7,307,594
1889	25,549	3,651,709	1923	23,420	4,894,239
1890	25,092	4,060,929	1924	18,068	4,791,426
1891	27,086	3,984,588	1925	14,678	4,048,911
1892	23,539	3,260,967	1926	12,244	3,451,108
1893	24,204	3,477,283	1927	9,316	2,853,637
1894	20,544	2,929,947	1928	6,667	1,815,549
1895	20,922	2,980,909	1929	6,240	1,709,950
1896	20,099	2,780,243	1930	4,973	1,371,073
1897	20,115	2,776,404	1931	4,848	1,352,981
1898	22,261	3,005,018	1932	4,077	1,209,894
1899	23,812	3,134,140	1933	3,006	906,878
1900	25,206	3,477,843	1934	3,866	1,128,673
1901	27,568	3,941,121	1935	4,902	1,640,303

[1] Data from U. S. Department of the Interior, General Land Office.

The use of water for irrigation at the mouth of mountain valleys proved so successful that this scheme of crop production in the semiarid region took gradual form. Where the cost of water diversion was beyond the means of one settler, groups combined to share the expense. From small beginnings this procedure has grown to large proportions and the Federal Government now finances projects through the Reclamation Service. That this development has been the major contribution to permanent crop agriculture in the West is generally recognized. Low-value, semiarid land, worthless except for natural forage, has been converted through irrigation into some of our most productive communities. To a large degree the successful use of adjacent range lands is dependent upon the forage raised in irrigated valleys. But there is a limit to the lands so situated that irrigation is feasible or possible; and even more important, there is a limit to the water available. There is little criticism against the homestead laws as applied to lands on which irrigation was practical.

As stated above, only a small part of the western range States can be irrigated (*169*). In Montana only 1.7 percent of the total land area has been placed under irrigation and not more than 2.8 percent can be so utilized. In Utah the corresponding percentages are 2.5 and 3.3. Even in California where the markets are close at hand and the climate is such as to permit of raising semitropical fruits, only 4.8 percent has been placed under irrigation to date.

And then someone discovered that dry-land farming was a possibility, and that under the influence of favorable years these virgin

grasslands could be made to grow wheat. That it had taken nature centuries to build up a few inches of fertile topsoil, that frequent and severe drought would result in crop failure, that the "summer-fallowing" practice was likely to facilitate wind erosion just as much as moisture conservation—these facts were not realized. Millions of acres of excellent native grassland passed to private owner-

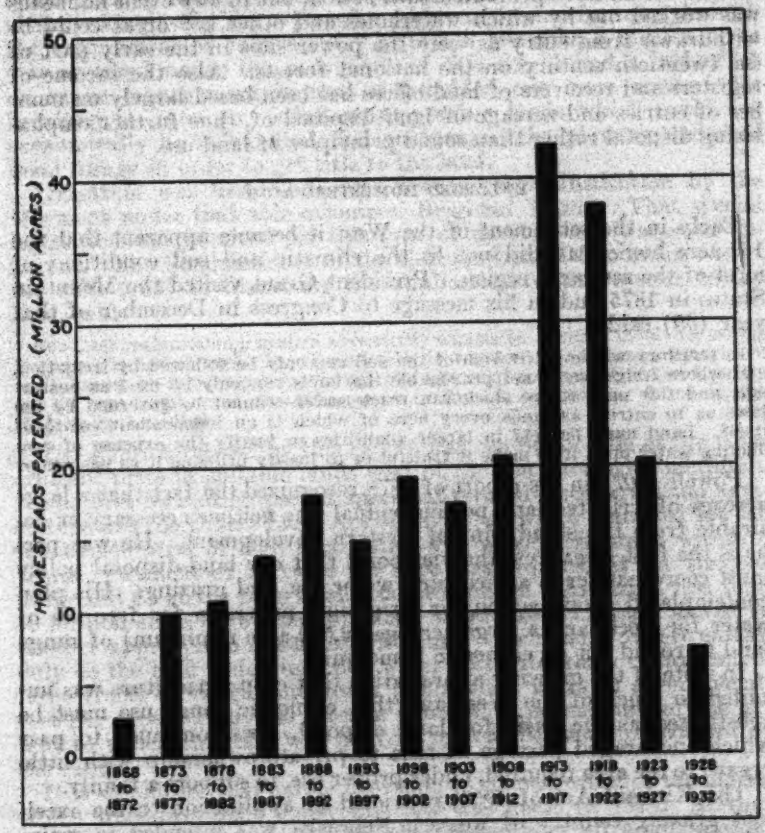

FIGURE 61.—THE RISE AND FALL OF HOMESTEADING IN THE WEST.

Homesteading east of the short-grass country had already slackened by 1868. These bars showing the acreage patented up to 1933 indicate, in the main, the sweep and decline of range-land homesteading. The sharp advance in the 1913–17 period is largely explained by the passage of the so-called Three-year Homestead Act of 1912.

ship under the homestead laws in a disastrous attempt to do what nature would not permit. Other millions of acres were filed on and broken up but were abandoned even before patent was issued. Today the semiarid West is dotted with abandoned shacks where a worn-out tractor stands back of the fallen-down barn, witnessing what has proved to be the crowning mistake of an attempt to force low-value lands into private ownership for crop agriculture.

Since the effects of the homestead law on the range resource cannot be segregated from the effects of all land-disposal laws, detailed discussion will be reserved for later presentation; but this much should be said here: The homestead law made no provision for adequate classification of the land to determine its suitability for crop agriculture. There is valid question whether this lack of a specific mandate need have prevented such action, but in any event no means was worked out by which waterholes and other key areas could be withdrawn from entry as were the power sites in the early part of the twentieth century on the national forests. Also the income of registers and receivers of land offices has been based largely on number of entries and acreage of land disposed of, thus further emphasizing disposal rather than sound principles of land use.

ENLARGED HOMESTEAD ACTS

Early in the settlement of the West it became apparent that the 160-acre homestead did not fit the climatic and soil conditions of most of the semiarid region. President Grant visited the Mountain States in 1875 and in his message to Congress in December of that year (*59*) said:

> In territory where cultivation of the soil can only be followed by irrigation, and where irrigation is not practicable the lands can only be used as pasturage, and this only where stock can reach water—cannot be governed by the laws as to entries as lands every acre of which is an independent estate of itself. Land must be held in larger quantities to justify the expense of conducting water upon it to make it fruitful or to justify utilizing it as pasturage.

Powell (*107*) in his report of 1878 recognized the fact that a large acreage of irrigated land per individual was neither necessary or desirable from the standpoint of western development. He was perhaps the first to express the viewpoint that our land-disposal policy must coordinate crop agriculture, water use, and grazing. His plan contemplated group action for irrigation, provision for free use of water for stock, and a large acreage (2,560-acre minimum) of range land to round out an economic home unit.

In spite of the growing appreciation that crop agriculture was unsuited to much of the West and that economic range use must be substituted as the basis for land disposal, laws continued to pass which encouraged passage of title to private ownership with little regard to the area required, under proper use, to support a family.

The Kinkaid Act of 1904, restricted in application to the excellent grazing country of western Nebraska was intended to maintain the fundamental principles of the homestead idea. The House Public Land Committee (*74*) in recommending its passage said:

> Increase in the area of homestead above that provided by the original Homestead Law—made with the view of compensating the homesteader, in a measure, in quantity of land for what the land lacks in quality and productiveness.

Within 10 years after the passage of the act, which increased the area of the homestead to 640 acres, practically all available lands under the act had been entered. That this act did not accomplish the purpose for which it was passed is established by the fact that much of the land of the original "Kinkaiders", long since abandoned for cropping, has been included in larger units for strictly range use.

The Enlarged Homestead Act of 1909, originally restricted in application to 9 States but later broadened to include 12, was even less wisely conceived. In the first place the homestead size was limited to 320 acres. It provided that one-fourth of the area be cultivated, that residence be the same as on all homesteads, and that none of the land be irrigable. Clearly the law was intended to include grazing lands, usually as pasturage for 160-acre homesteads already occupied. Yet it placed a premium on dry-farming through the requirement of cultivation. Although less than 3 million acres was acquired under the provisions of this act, it had a bad effect on range management in that it provided one more method for breaking up into very small units grazing lands which could not economically be so handled, and encouraged the plowing under of good forage in order to get title to the land.

Irrigation was first made into a cooperative institution by the Mormons under that able colonizer, Brigham Young. That special legislation was required for this type of development was soon apparent. The Commissioner of the General Land Office in his report for 1875 (*168*) in discussing the application of this system to the land, said:

> For their reclamation a system necessarily expensive, because involving canals or main ditches of great length and size, is required; and, hence, associated capital must be called upon to furnish the means of success. But the security for its repayment, even the inducement to furnish it, must be found in the lands to be benefited.

The solution offered by this report was the public sale at the Government price of suitable lands west of the one hundredth meridian.

The first legislation passed specifically to advance irrigation agriculture was the Desert Land Act of 1877 (*74*) which provided for the sale of 640 acres of land to a settler who would irrigate it within 3 years. Payment of 25 cents per acre was required at the time of filing and $1 at the time final proof was made. Although less than 10 million acres have gone to patent under this act, it has served as another approach to misuse of the range. By making desert entries only on the land which included water holes, stockmen could control large tracts of range land for a period of 3 years at a very small cost per acre. Thus, the acreage patented is no measure of the extent to which this law was used in the competition for control of the range.

It is significant that ample provision to correct many of the abuses which were prevalent under this law was made in 1888. At that time a law was passed (*74*) which directed that all lands selected as sites for reservoirs, canals, and ditches and all lands susceptible of irrigation by such means be withdrawn from entry. Despite this sweeping bit of legislation, no constructive action was taken to correct the situation.

THE GRAZING HOMESTEAD LAW

Shortly after the cattle boom of the eighties, farsighted men began to realize that the range resource was not in fact inexhaustible. Reports began to spread that the ranges were overcrowded and as a result were being permanently damaged. In recognition of this, President Theodore Roosevelt in 1903 appointed a commission con-

sisting of W. A. Richards, Commissioner of the General Land Office, F. H. Newell, Chief Engineer of the Reclamation Service, and Gifford Pinchot, Forester of the Department of Agriculture, to make an investigation, report upon conditions, and recommend such changes as were needed in the land laws. The report of this commission (*140*) submitted by the President to Congress in 1905–6 clearly set forth what was happening:

> The general lack of control in the use of public grazing lands has resulted, naturally and inevitably, in overgrazing and the ruin of millions of acres of otherwise valuable grazing territory. Lands useful for grazing are losing their only capacity for productiveness, as, of course, they must when no legal control is exercised.

Included in this report were the results of a study made by A. F. Potter, who through extremely wide acquaintance with stockmen of the West, was able to get an expression of opinion from some 1,400 stockmen well distributed over the range States. The preponderance of the expressions were favorable to some sort of Federal administration of grazing on the public domain. This coincided with the views of the commission. They made such a recommendation and strongly urged that the range lands be withdrawn from selection under the homestead and desert homestead laws. No constructive action was taken. On the contrary, by 1916 pressure became so great that the most unfortunate of the land-disposal laws as applied to range lands was enacted, the Grazing Homestead Act.

Instead of recognizing the similarity in principle between the treatment required for timber lands and that required for low-value range lands and providing a companion act to the Forest Reserve Act passed in 1891, we clung to the private-ownership philosophy.

Bad as have been the effects of this law, there was within it one provision subject to an interpretation which could have prevented most of the difficulty:

> The Secretary of the Interior is hereby authorized, on application or otherwise, to designate as stock-raising lands subject to entry under this act, lands the surface of which is, in his opinion, chiefly valuable for grazing and raising forage crops, do not contain merchantable timber, are not susceptible of irrigation from any known source of water supply, and are of such character that 640 acres are reasonably required for the support of a family.

The actual interpretation which has been given the above clause has been so completely at variance with that contemplated at the time the law was passed that some discussion is essential. A study of the facts has been made by Dr. E. A. Sherman, Assistant Chief, United States Forest Service, who says:

> Associate Forester Albert F. Potter, on December 9, 1916, while the measure was in conference, called the attention of Assistant Secretary of the Interior Finney to the above language, and suggested that the last clause be amended to read, "and are of such character that 640 acres may reasonably be expected to support a family." Mr. Finney reported that Secretary Lane (Interior) approved the change, and, under instructions from Secretary Houston (Agriculture), Mr. Potter presented it to Congressman Scott Ferris, who called the conferees together and secured favorable consideration of Mr. Potter's proposal. All of the conferees were in favor of the amendment, but ruled that it would be subject to a point of order, and it was therefore not included. Congressman William Kent, of California, opposed the measure in conference because he was fearful that as worded it would permit the classification of all lands which were not of a character on which a man could make a living on less than 640 acres. This resulted in a conference with Assistant Secretaries

Finney and Vogelsang, Mr. Mahaffey, Forester H. S. Graves, and Associate Forester Albert F. Potter. The representatives of the Department of the Interior contended that the Secretary of the Interior was given a wide discretion and need designate "only such lands as in his opinion were suitable for the purposes of the law", with the understanding that the lands to be designated would be passed on by the United States Geological Survey and would be of such a character that 640 acres "may reasonably be expected to support a family." The measure was thereupon accepted by the representatives of the Department of Agriculture. Mr. Kent withdrew his objection, and Secretary of Agriculture Houston advised the President that:

"The Secretary of the Interior is required to designate the lands as 'stock-raising lands' before they may be entered, and he can designate only such lands 'the surface of which is, in his opinion, chiefly valuable for grazing and raising forage crops, do not contain merchantable timber, and are not susceptible of irrigation from any known source of water supply, and are of such character that 640 acres are reasonably required for the support of a family.' As I interpret it, in order to designate such lands, the Secretary must of necessity have a classification made. He cannot permit any applicant to secure a homestead in excess of 640 acres, and he must have reasonable assurance that the 640 acres applied for will be reasonably required for the support of a family. I do not understand that there could be created under the act a homestead of 640 acres on which the entryman might not reasonably expect to support his family."

With the foregoing understanding, Secretary Houston raising no objection to the approval of the measure as finally passed, it was signed by President Wilson and became a law.

For a time the Geological Survey appears to have endeavored to adhere to the requirement that in order to be classified as subject to entry under the stock-raising homestead law the land must be capable of supporting a family on 640 acres and millions of acres were so classified, but political pressure resulting in adverse rulings by the Department forced abandonment of the policy for a rule-of-thumb requirement that the land be capable of supporting not less than 30 head of cattle yearlong for each 640-acre entry. This was in turn abandoned for the same reasons, and most anything short of absolute desert was given stock-raising homestead classification. Testifying before the House Committee on Public Lands, February 18, 1934, Congressman Taylor, of Colorado, stated that up to June 30, 1933, 24,326,349 acres of land had passed to patent, and an additional 124,009,640 acres had been classified and designated as subject to the act.

The upshot of the whole matter was another outstanding example of a reasonably good law unwisely and improvidently administered. The Department of Agriculture had conceived the purpose of the bill to be the establishment of "stock-raising homes" and not "stock-raising entries."

The extent to which the stock-raising homestead law has been used is shown by tables 41 and 42. It is significant that of the more than 68 million acres entered under this law only approximately 26 million acres have gone to patent and only about 14 million acres are now pending. Thus nearly 28 million acres are represented by entries which were abandoned before proof was made. The financial and spiritual toll exacted from tens of thousands of families that were permitted to try a venture in which they were doomed to failure is a convincing confutation of the theory, "Let the purchaser beware."

TABLE 41.—*Area (in acres) of stock-raising homesteads entered from passage of the Grazing Homestead Act to June 30, 1935* [1]

State	1918	1919	1920	1921	1922	1923	1924	1925	1926	1927
Arizona		104,001	136,016	265,361	312,576	187,225	169,524	66,270	66,210	125,119
California		134,666	464,527	485,773	575,169	314,066	309,944	177,198	174,718	159,511
Colorado	960	214,660	1,060,288	1,088,823	702,730	615,988	373,404	238,007	198,240	209,436
Idaho		113,819	476,222	611,274	394,234	324,973	188,812	146,943	131,626	172,220
Kansas	2,014	27,794	6,252	9,688	5,579	2,267	1,228	2,888		
Montana		314,512	1,012,688	1,067,888	1,286,300	483,619	272,926	240,884	253,664	267,260
Nebraska		6,726	10,944	13,964	10,188	14,570	3,407	11,257	6,068	5,781
Nevada		18,130	87,148	79,638	82,114	27,598	22,573	28,157	27,573	24,228
New Mexico	30,542	1,311,573	844,127	1,277,788	1,612,167	647,484	397,434	338,271	290,620	284,888
North Dakota	62,986	14,428	85,038	14,201	15,468	24,877	5,468	4,979	1,680	2,848
Oklahoma		14,413	2,134	1,201	17,207	11,164	7,260	7,461	2,157	7,211
Oregon		149,274	660,068	688,461	898,211	399,888	187,888	149,445	98,488	102,464
South Dakota	33,468	857,922	888,267	615,888	179,227	125,844	61,451	52,488	32,788	49,158
Utah	835	66,128	160,784	201,822	154,884	102,885	128,804	122,874	102,272	218,422
Washington		73,861	89,211	78,279	73,470	30,788	15,871	28,157	16,410	8,478
Wyoming	52,607	1,302,464	2,788,136	3,018,848	1,945,081	845,484	480,119	809,108	444,881	863,188
Total	212,709	5,431,780	9,080,607	10,138,898	6,866,617	4,122,468	2,766,681	2,217,381	2,128,787	2,871,228

State	1928	1929	1930	1931 [2]	1932 [3]	1933 [4]	1934 [5]	1935 [6]	Total
Arizona	179,600	271,849	363,490	274,111	283,231	169,468	122,660	43,179	2,993,368
California	188,270	162,058	221,597	140,911	145,018	116,771	82,810	58,766	3,435,427
Colorado	221,965	271,997	312,968	272,270	226,981	169,888	166,988	68,425	7,082,756
Idaho	136,980	160,943	179,499	201,174	152,989	102,963	127,814	61,607	4,898,544
Kansas									56,617
Montana	269,968	318,264	421,530	361,023	321,005	218,720	209,947	104,489	7,888,888
Nebraska	3,408	7,144	5,870	6,270	3,261	3,068			106,918
Nevada	24,024	23,408	27,039	21,208	20,287	21,784	8,188	845	688,158
New Mexico	468,406	898,027	1,013,865	1,268,411	1,068,013	715,809	391,676	13,290	12,888,888
North Dakota	5,804	2,912	8,972	12,830	14,871	7,284	11,579	8,861	388,088
Oklahoma									71,248
Oregon	109,578	118,618	110,908	127,288	76,421	60,784	88,280	87,748	8,888,884
South Dakota	51,016	52,752	82,446	48,266	48,574	30,880	30,772	41,051	8,888,888
Utah	176,840	288,488	818,408	188,818	161,867	91,928	75,867	87,188	2,788,884
Washington	8,284	4,897	8,488	14,478	6,881	5,988	8,979	8,888	427,888
Wyoming	718,880	888,008	1,081,788	1,081,888	971,885	688,804	778,888	288,788	18,888,888
Total	2,868,829	3,484,948	4,888,488	4,052,088	3,418,887	2,881,888	2,488,818	1,884,988	88,888,888

[1] Report of Committee on Conservation and Administration of the Public Domain (*25*), pp. 41–42.
[2] Annual Report of the General Land Office, 1931 (*169*), pp. 74–75.
[3] Annual Report of the General Land Office, 1932 (*164*), pp. 76–77.
[4] U. S. Department of the Interior, General Land Office. Annual Report of the Commissioner of the General Land Office to the Secretary of the Interior, 1933. 108 pp., 1933. [Typewritten.]
[5] Statistical Abstract of the United States, 1934 (*189*), p. 128.

TABLE 42.—*Area (in acres) of stock-raising homesteads patented fiscal years 1919 to 1935* [1]

State	1919	1920	1921	1922	1923	1924	1925	1926	1927
Arizona	320	9,920	58,000	73,845	85,313	73,862	101,[illegible]	98,[illegible]	100,[illegible]
California	1,451	4,248	34,783	82,242	135,[illegible]	103,851	127,[illegible]	140,[illegible]	103,[illegible]
Colorado		24,173	144,210	308,476	380,002	295,[illegible]	257,[illegible]	244,[illegible]	230,[illegible]
Idaho		6,701	38,272	53,643	61,103	53,[illegible]	61,121	138,[illegible]	113,[illegible]
Kansas	200	2,240	9,017	12,231	4,[illegible]	5,[illegible]	5,[illegible]	5,[illegible]	[illegible]
Montana		29,940	144,199	328,416	304,235	226,[illegible]	227,[illegible]	313,[illegible]	270,112
Nebraska			699	4,336	5,921	10,910	4,[illegible]	5,[illegible]	6,218
Nevada				2,400	10,953	13,201	15,210	16,[illegible]	36,[illegible]
New Mexico	1,527	57,370	233,133	451,778	431,370	518,[illegible]	418,019	391,[illegible]	439,[illegible]
North Dakota	751	13,796	16,585	14,346	15,207	15,272	4,047	5,514	4,[illegible]
Oklahoma			1,402	2,783	2,941	5,210	3,[illegible]	5,[illegible]	5,[illegible]
Oregon		9,714	67,923	142,018	131,[illegible]	207,170	165,747	198,081	146,841
South Dakota		58,399	169,745	217,[illegible]	141,702	207,031	144,427	141,[illegible]	88,[illegible]
Utah			478	10,977	6,[illegible]	27,[illegible]	22,[illegible]	55,[illegible]	73,514
Washington		2,660	16,358	19,408	22,[illegible]	24,[illegible]	29,011	34,[illegible]	27,[illegible]
Wyoming	650	110,497	224,302	1,110,[illegible]	887,[illegible]	873,731	692,[illegible]	648,[illegible]	495,[illegible]
Total	4,899	376,[illegible]	1,249,[illegible]	2,919,[illegible]	2,[illegible],000	2,922,[illegible]	2,[illegible],[illegible]	2,[illegible],[illegible]	2,[illegible],[illegible]

State	1928	1929	1930	1931	1932	1933	1934	1935	Total
Arizona	94,[illegible]	68,012	54,[illegible]	59,[illegible]	64,[illegible]	62,[illegible]	58,[illegible]	104,[illegible]	1,[illegible]
California	100,171	68,[illegible]	62,[illegible]	80,[illegible]	93,[illegible]	67,[illegible]	80,[illegible]	98,[illegible]	2,[illegible]
Colorado	102,[illegible]	142,[illegible]	125,[illegible]	126,[illegible]	126,[illegible]	111,[illegible]	40,[illegible]	93,[illegible]	[illegible]
Idaho	51,[illegible]	60,[illegible]	60,[illegible]	44,[illegible]	55,[illegible]	44,[illegible]	33,[illegible]	51,[illegible]	[illegible]
Kansas	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Montana	220,[illegible]	195,[illegible]	169,[illegible]	125,[illegible]	126,[illegible]	67,[illegible]	61,[illegible]	101,[illegible]	2,[illegible]
Nebraska	4,[illegible]	[illegible],[illegible]	[illegible],[illegible]	[illegible],[illegible]	[illegible],[illegible]	[illegible],[illegible]	[illegible],[illegible]	[illegible],[illegible]	[illegible]
Nevada	13,[illegible]	13,[illegible]	12,[illegible]	11,[illegible]	12,[illegible]	7,[illegible]	4,[illegible]	4,[illegible]	165,[illegible]
New Mexico	257,[illegible]	207,[illegible]	194,[illegible]	201,[illegible]	180,[illegible]	222,[illegible]	187,[illegible]	208,[illegible]	4,[illegible]
North Dakota	[illegible],[illegible]	[illegible],[illegible]	[illegible],[illegible]	[illegible],[illegible]	[illegible],[illegible]	[illegible]	[illegible]	[illegible],[illegible]	[illegible]
Oklahoma	[illegible],[illegible]	[illegible],[illegible]	[illegible],[illegible]	[illegible],[illegible]	[illegible],[illegible]	[illegible]	[illegible]	[illegible],[illegible]	[illegible]
Oregon	53,[illegible]	64,[illegible]	52,[illegible]	59,[illegible]	39,[illegible]	18,[illegible]	25,[illegible]	36,[illegible]	1,[illegible]
South Dakota	60,[illegible]	48,[illegible]	30,[illegible]	39,[illegible]	35,[illegible]	22,[illegible]	7,[illegible]	18,[illegible]	1,[illegible]
Utah	49,[illegible]	32,[illegible]	61,[illegible]	67,[illegible]	55,[illegible]	56,[illegible]	31,[illegible]	51,[illegible]	[illegible]
Washington	17,[illegible]	14,[illegible]	[illegible],[illegible]	[illegible],[illegible]	[illegible],[illegible]	[illegible],[illegible]	[illegible],[illegible]	[illegible],[illegible]	[illegible]
Wyoming	[illegible],[illegible]	[illegible],[illegible]	[illegible],[illegible]	[illegible],[illegible]	[illegible],[illegible]	[illegible],[illegible]	[illegible],[illegible]	[illegible],[illegible]	7,[illegible]
Total	1,[illegible],[illegible]	1,[illegible],[illegible]	1,[illegible],[illegible]	1,[illegible],[illegible]	1,[illegible],[illegible]	[illegible],[illegible]	[illegible],[illegible]	1,[illegible],[illegible]	26,[illegible]

[1] Report of Committee on Conservation and Administration of the Public Domain (35), p. 43.

LAND SCRIPT, MINERAL LAWS, AND OTHER ACTS

Although the various homestead laws account for the great bulk of the land which has passed direct from the public domain to private ownership, many other methods to accomplish this purpose have been legalized. The issuance of script redeemable in land to be taken from the public domain has not been uncommon. Eastern States, not so fortunate as to contain public domain, and Texas, have been issued land script to the extent of 7,830,000 acres to be selected in public-land States for the support of education. Recognition of the obligation which the Nation owes to soldiers of the various wars has been met in part by the issuance of land script covering more than 1.6 million acres of public lands (*35*). These promises of lands were made transferable and therefore soon found their way into the channels of trade. During certain periods the buying and selling of script assumed major proportions on the stock markets. It is impossible to estimate the extent to which script was used in acquiring range lands, but it is well known that a great part was gathered in by timber companies as one means of bringing about the consolidation of ownership of the choicest timberlands of the West.

Mineral and coal land disposal under the various laws had taken less than 4 million acres by 1931. Although no objection is here raised to the validity of encouraging the development of mining by this method, it is unfortunate that the mining laws have at times been used for purposes not intended under the laws. Too often mining claims of questionable mineral value have been located in the heart of range units or to control the use of water. Thus proper range management has been made more difficult. Coordinated use of our natural resources, under which the needs of the mines and miners are given full consideration, would seem to be a more logical principle to follow than that of passing to patent or control a grazing resource in which the patentee presumably is only incidentally interested.

Many methods other than those discussed have been used to pass to private ownership title to range lands, but the principles involved and the effects on range depletion are similar. The Timber Culture Acts, the Timber and Stone Act, the Carey Reclamation Act, and the various cash-sale provisions are a few that should be listed even though space limitations prevent discussion.

RAILROAD AND OTHER INTERNAL IMPROVEMENT GRANTS

Perhaps the main deterrent to rapid settlement and development of the West was the lack of adequate transportation facilities. The idea that the disposal of public lands should aid in solving this problem was early conceived. Precedent for the use on a large scale of the proceeds from the sale of public lands is first found in the Enabling Act of the State of Ohio in 1802 (*74*). It provided that 5 percent of the gross receipts from such sales should be made available and used for the building of public roads. Following this, grants for transportation development were numerous. Some were made to States with stipulations as to how the money was to be used, but more frequently the grant was direct to the railroad as a subsidy to aid in financing the original construction. This phase

of our land-disposal policy reached its peak in the sixties when the grants to the Union Pacific, Central Pacific, Northern Pacific, Santa Fe, and Southern Pacific were consummated. The magnificence of these subsidies soon raised so much opposition that the practice was stopped with the exception of relatively minor grants for the purpose of financing a few branch lines, connecting links, and to aid in consolidations. Altogether, as shown in table 43, more than 101 million acres were granted to States and corporations to advance railroad building in the range country. Figure 62 presents graphically their extent and location.

TABLE 43.—*Status of railroad grants*

State	Original grants [1]	Present [2] holding railroads [3]	Additional grants to States for railroad and wagon roads [4]
	Acres	*Acres*	*Acres*
Arizona	8,419,808	[5] 3,770,896	
California	11,681,429	2,058,451	
Colorado	3,826,981	94,580	
Idaho	1,615,479	870,148	
Kansas	7,940,852	4,735	4,634,227
Montana	14,242,510	3,818,441	
Nebraska	7,867,737	18,611	
Nevada	4,086,078	4,440,078	
New Mexico	3,464,049	[6] 1,437,631	
North Dakota	10,301,913	16,364	
Oklahoma		2,207	
Oregon	3,480,460	102,529	2,563,950
South Dakota [7]		4,963	
Texas [8]		136,194	
Utah	2,277,230	673,251	
Washington	6,930,542	1,531,899	
Wyoming	5,104,736	982,603	
Total	94,149,965	19,206,178	7,218,177

[1] Bureau of Railway Economics unpublished data as of June 30, 1923.
[2] From unpublished data of Interstate Commerce Commission, 1924.
[3] Exclusive of rights-of-way and urban property.
[4] These lands were transferred to construction companies or railroads.
[5] Includes 2,755,581 acres transferred to holding company for Atchison, Topeka & Santa Fe Railroad Co.
[6] Includes 1,431,641 acres transferred to holding company for Atchison, Topeka & Santa Fe Railroad Co.
[7] Small acreage included with North Dakota.
[8] The railroad lands in Texas were direct grants by the State—total grants to railroads, 32,132,976 acres (*141*).

While the stipulations differed in the various grants, the usual procedure was to include all of the alternate sections for a distance varying as between grants from 10 to 40 miles on each side of the right-of-way. Provision was made for the selection of "lieu lands", generally within 10 miles beyond this limit, in lieu of lands which had already been settled, were mineral in character, or for any other reason were not available to the railroad company. That the railroad grants accomplished their major purpose cannot be questioned. Transcontinental lines were financed and pushed through much sooner than they otherwise would have been.

In the final analysis these grants were intended to encourage passage of title to private owners in small tracts similar to the homestead law. Stipulations were usually included which controlled the price at which the land could be offered for sale and which required that it be offered by a certain specified time after construction. Table 43 shows that in the range States more than 19 million acres still remain in railroad ownership.

It is significant that in the administration of the railroad-grant laws the Federal land policy of passing of title to private ownership is clearly shown. Vigorous protests by the Forest Service against further patenting of land to the Northern Pacific Co. resulted in the passage of Public Resolution 24, Sixty-eighth Congress, on June 5,

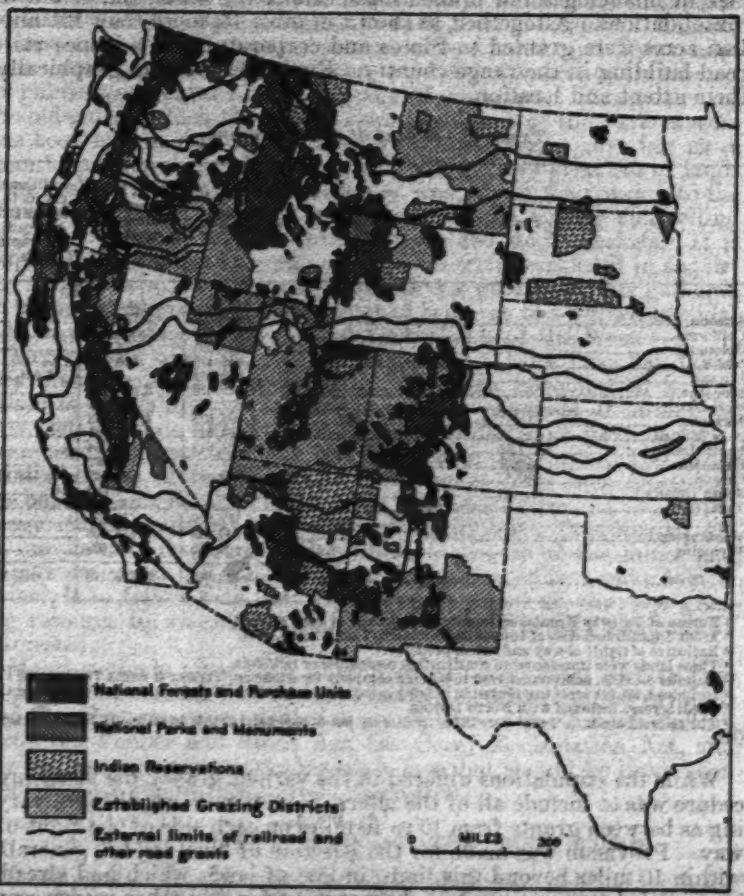
National Forests and Purchase Units
National Parks and Monuments
Indian Reservations
Established Grazing Districts
External limits of railroad and other road grants
0 MILES 200

FIGURE 82.—HOW RAILROAD GRANTS COMPLICATED THE OWNERSHIP PATTERN.

The various railroad land grants of alternate sections within the limits shown above included an extremely large acreage of grazing lands. Federal reservations and withdrawals later overlapped these grants. These grants still complicate the ownership pattern.

1924. Among other provisions this resolution created a joint committee of both Houses of Congress to make a complete investigation of the Northern Pacific land grants. Hearings were held and the complete record was submitted to the Attorney General for analysis and advice. His findings (*147*) are summarized:

A consideration of the foregoing suggestions indicates that not only does no deficiency exist in the grants but that the company has already received approximately 5 million acres of public land which it has not earned and is not entitled to.

Final disposition of this case is still in the courts.

Naturally the land-disposal policy of the railroads has had two purposes: (1) The conversion of land into money and (2) the settlement at the most rapid rate of the territory served. High-pressure salesmanship was resorted to in furtherance of these aims. Certain roads even went so far as to open land offices in the capitals of Europe. Here was developed the land agents' viewpoint on a wholesale basis. Colonization schemes destined to failure were undertaken on a grand scale. The ease of irrigation, and the profits to be had from dry-land farming were presented in glowing terms. Thus many more millions of acres of typical range land, unsuited to crop agriculture, were put to the plow.

Fortunately the sales policy of most of those roads which still have lands to sell has reversed. It is now realized that, in the long run, the railroads can benefit only as the individual purchaser is successful. Misuse of the land is discouraged. Purchasers destined to failure because of inexperience are not solicited, and prices are set at the figure at which the purchaser has a chance to retain title. In most instances the railroads are in the vanguard of the movement to bring about some orderly plan of action which will insure stable and profitable use of the land. However, the checkerboard pattern of the railroad holdings makes difficult any sort of blocking up of range-land tenure in tracts of sufficient size to permit of economical livestock operations. In the establishment of one large grazing district in Montana, however, the Northern Pacific Co. took a leading part. Their own holdings, which were a large percentage of the total, were turned in to the grazing association at a very low rental price.

A part of the railroad lands are given relatively good management. Those sections which fall within the national forests usually can be used only in connection with adjoining lands. Thus they are usually leased by a national-forest permittee who turns them in to the Forest Service for a permit to graze the number of stock equivalent to the determined grazing capacity of the land.

Not much can be said in favor of the range practice required on most of the railroad lands. It consists simply in leasing the lands without restrictions as to numbers of stock to be grazed or the season during which the land may be so used. Presumably it is assumed that the lessor will protect the resource. As a usual practice the lands are first offered to the logical local user or users. If the lease is not thus taken up, the lands are then offered to the highest bidder, who more often than not secured the land for less than the annual taxes assessed against it. Much of the land is never leased at all, because it is so badly intermingled with other holdings that it cannot be protected from trespass.

Status of Lands Remaining in Public Ownership

TEXAS LANDS

The treaty of annexation of Texas, signed in 1845, provided, as already stated, that the new State would retain title to the lands within its borders. Thus we have an example of land disposal on a large scale by the individual State. That the land-ownership pattern of Texas is extremely complicated can be more readily understood if it is realized that previous to its annexation by the United States it had been, first, a Spanish Province, then in 1820 a part of the "State of Coahuila and Texas" under the Government of Mexico, and lastly, a sovereign independent nation.

The first title to land in Texas probably dates back to 1731 under a grant from Spain (*87*). From that date until 1819 various large and small grants were made by the Spanish Kings. In most instances the motive back of the grant was the extension of the Catholic religion and the colonization of the province. Although permanent settlements through Spanish efforts seem to have been a failure, it is estimated that private title to about 10 million acres of land [87] goes back to this source.

The Mexican influence on land ownership in Texas is very pronounced. It too was designed to encourage settlement and perpetuate the ruling religion, but it did set up a land-disposal scheme which had some merit. Under it, with certain restrictions as to residence and citizenship, an area of land varying from 177 acres of tillable land to 4,251 acres of grazing land could be secured by one individual. In addition, anyone who would organize a colony of 100 or more families received a liberal reward in land. Though many minor changes and modifications were made, the system thus started remained in effect until 1845 as the land policy of the Republic of Texas. Under the system more than 16 million acres passed to private ownership.

Texas, as a State, as shown in the following tabulation (*142*), has used almost every known device except the lottery system in its public-land disposal.

	Acres
Grants by Spain and Mexico	26,268,000
State university	2,221,400
Klamaaha Road	27,000
To build State capitol	3,050,000
County courthouses	640
San Jacinto Veterans	1,169,382
Disabled Confederates	1,979,852
Homestead donations (preemption)	4,847,136
Internal improvements	4,061,000
Counties for schools	4,229,166
Headright and bounties	36,878,492
Colonies	4,494,806
Railroads	32,153,878
Asylums	400,000
Public free schools	42,400,556
Total	164,191,308

[87] Some estimates are as high as 20 million acres (*87*).

Free homesteading has been encouraged, soldiers have been reimbursed in land and in land script, construction companies were paid in land for the construction of public buildings, large quantities were donated for internal improvements, it has been sold outright as a means of raising revenue, and an enormous area has been used to endow the public schools and institutions of higher education. Thus the land history of Texas is similar to that of the Nation except that more consideration was given to the relationship of size to intended use. That private range lands in Texas have been depleted to substantially the same degree as have those in adjoining States is evidence that size is not the only answer to the proper use of such a resource. Current profits, inadequate finances, and failure to consider the forage as a renewable resource seem to have controlled here as elsewhere.

Those lands which remain in the various forms of State or institutional ownership are managed primarily for the greatest current revenue. No adequate provision has been made in leases and use agreements to perpetuate watershed values of the range forage resource at a permanent high level. Cents per acre rather carrying capacity has controlled in large measure.

In all of the range States except Texas, State ownership of land largely goes back to Federal grants for educational purposes or for public or semipublic improvements.

STATE GRANTS

That the use of public lands for educational purposes and for essential public improvements was a laudable purpose has been demonstrated. Our common-school system, our land-grant colleges, and our other favored institutions have benefited greatly. That they might have benefited more in the long run under a plan of land management which would have protected the range resource for both present and future generations seems equally clear.

Proposals that a portion of the public lands or of the receipts from the sale of public lands be distributed to the States probably originated in 1824 when a proposal was made that money from the sale of lands be invested, and the interest therefrom be distributed among the States. The following year a congressional committee was appointed to investigate the possibilities of such a plan with special reference to the possibility of using the money to finance a public-school system and of the effect of such a plan on the colonization and development of the United States (74). The committee report was favorable, but the question was destined to occupy the middle of the political stage many years before the principle was finally accepted.

It is not the purpose of this report to present the detailed history of Federal grants to the States of lands or money from the sale of lands. The system was followed and has done much to foster the cause of education and public improvements. Table 44 shows the extent of such grants and present ownership in the western range States.

TABLE 44.—*State land status for 17 entire Western States*

State	Original grants	Total present ownership	Range land owned	Range land leased	Administrative agency of State lands
	Acres	*Acres*	*Acres*	*Acres*	
Arizona	10,542,113	8,226,627	8,263,627	7,599,630	State land commissioner.
California	8,427,077	1,042,854	442,369	30,499	Division of State lands, department of finance.
Colorado	4,423,680	3,182,102	2,995,737	2,426,165	State board of land commissioners.
Idaho	3,682,157	2,881,286	1,305,282	1,702,944	State board of land commissioner's department.
Kansas	3,685,910	71,302	71,302	None	State auditor's office.
Montana	5,989,513	4,941,085	4,319,996	2,982,981	Department of State land and investments.
Nebraska	3,413,711	1,724,143	1,574,143	[1] 1,691,549	Commissioner of public lands and buildings.
Nevada	2,722,647	139,887	117,887	[2] None	Surveyor general and State land register.
New Mexico	13,722,994	13,697,651	13,189,651	[3] 10,705,689	Commissioner of public lands.
North Dakota	3,189,541	1,933,045	1,585,981	1,173,422	Commissioner of university and school lands.
Oklahoma	3,995,760	880,960	468,960	327,641	Commissioner of State land office.
Oregon	4,375,429	611,927	540,707	39,524	State land board and rural credits department.
South Dakota	5,434,303	3,981,080	3,809,340	2,623,427	Commissioner of school and public lands.
Texas		22,426,931	18,964,426	2,270,283	General Land Office of Texas.
Utah	7,464,276	2,920,000	2,207,200	227,661	State land board.
Washington	3,045,471	3,260,796	1,196,976	466,622	State land commissioner of public lands.
Wyoming	4,125,989	3,867,242	3,223,242	2,988,882	Commissioner of public lands and farm loans.
Total	84,142,734	72,254,021	65,052,441	55,980,913	

[1] Probably includes agricultural lands.
[2] No State lands leased; all are sold outright or on long-time payment plan.
[3] Includes small percentage of agricultural lands.

As a result of apparent fraud in disposing of land in the earlier grants, most of the grants, or the State constitutions, placed limitations on freedom of action in disposing of the land. Obviously the main reason back of the restrictions was a fear that State governments would be dominated by political influence and as a result the lands would be disposed of as political or personal favors and at a fraction of their true value. Thus, in most grants, stipulations as to minimum selling prices and restrictions on sales are to be found. In several States the minimum price was so high in relation to resource values that it prevented disposal of any but the best land. Apparently the price set was based on the belief that all land would ultimately command a substantial price and on a desire to obtain all that the traffic would bear in State land disposal.

Regardless of the justification from other standpoints, range management on State lands has been seriously hampered by the scattered geographic distribution of the land over the States. The usual custom has been to designate sections 16 and 36 of each township as common-school land. In Arizona, New Mexico, and Utah sections 2 and 32 were also so designated. Only in Nevada was this problem avoided; here, in lieu of a grant of named sections, the State ultimately was given the right to select from any unreserved and unappropriated public lands 2 million acres for common-school purposes (*74*).

This distribution in small units, rather than in tracts of sufficient size for efficient administration, would go far toward preventing the

application of sound range management principles even if those responsible for the handling of such lands so desired.

The State of Nevada based the location of its school-land selections on salability, especially as influenced by the control of water, which was especially vital to the use of the range. Thus in this instance the State land furnished the key to the use of an immense area of surrounding public domain, and this explains in part why such a large part of Nevada's common-school land has passed to private ownership.

Attempts at consolidation of State land in the public-land States of the West in blocks large enough for management have been made with more or less success. The greatest aid to this endeavor has been the various lieu selection acts. Title to land granted the States did not pass until the lands were surveyed and the survey accepted. Meanwhile the State grant might be defeated as to a given area either by settlement prior to survey or by inclusion in some reservation in which case title did not pass so long as the land was reserved. To meet such situations equitably the States were given the right to select an equal area of nonmineral, unreserved and unoccupied, surveyed public land anywhere within the same State, regardless of value. This provision proved of great value, especially where national forest reservations embodied great areas of unsurveyed, rough mountain land. The theoretical school sections were promptly surrendered, and the best of the remaining unreserved public domain was selected instead.

In 1907, in order to facilitate and encourage consolidation and management of State lands, the Forest Service agreed to eliminate certain agreed-upon areas from the national forests for selection by the various States on an "equal area—equal value" exchange basis. In some States part or most of the selected land was primarily valuable for grazing. This was true in part in Montana, Idaho, Washington, Wyoming, New Mexico, and other States.

Likewise, in a few States exchanges of patented State lands within the national forests for other unreserved lands of equal area and value have aided materially in consolidation. That other States have not followed a similar course results in part from a lack of permissive legislation.

It should be added that in most grants, other than those for the support of the common schools, the States were permitted to select the specified area from any unreserved and unappropriated public domain. This was true with the large grants for the various State colleges and universities and for many internal improvements. In many instances these selections were made in blocks of large size.

In many of the States it has been the practice to invest the receipts from the sale or lease of State land in real-estate mortgages. A large part of these investments were made during the dry-farm boom and were for amounts which we now know were in excess of the actual worth of the land. Although foreclosures have been avoided when possible, some States have by this means acquired a substantial additional acreage of denuded lands and are destined to acquire much more. Here again the land distribution is in small units and serves to add to the confusing pattern of State land ownership.

The handling of State range land has been based almost wholly on a desire to secure the maximum current revenue.[18] Sale of the maximum acreage has been encouraged without regard for the fitness of the land for private ownership. Leasing has usually been with a view to securing the greatest possible price. No provision has been made for the protection of the range and watershed resources through wise management. A search through the last annual land report of all the range States fails to reveal any mention of the condition of the lands. Without exception they are mere financial statements made up largely of figures of acreages and dollars. The measure of success seems to be based entirely on the ability of those responsible for the lands to obtain the maximum revenue from lease or sale regardless of the effect on the resource.

In every case responsibility for administering State lands rests with those whose major function is revenue collection. In no instance has the land been turned over to an agricultural agency. Surprising as it may seem, even where a qualified State agricultural department is provided it has been permitted to have no part in State land management other than that which could be exerted indirectly through influence. Clearly, in the interest of good land management, the administration of State grazing land should be closely tied in with the interrelated agricultural interests. Sound land-use management requires this action.

To sum up: The distribution pattern of State lands is of such character as to complicate any attempts at improved range management. No provision at all to control numbers of stock or season of use is exercised in leases. Supervision of the use of the land is not provided. The responsible agency is primarily interested in securing the greatest current revenue through sales or leases. The services of existing qualified agencies such as the State agricultural departments, the agricultural experiment stations, and the Extension Service are little used.

INDIAN LANDS

The land ownership problem within the western Indian reservations, especially those of the Northwest, is little if any less complicated than with the land in other forms of ownership or control. Until very recently the objective in Indian administration seems to have been to lead or force the Indian to accept the same mode of living and standards of civilization that have proved to be satisfactory to the white man. This has included the principle of individual, private ownership of land as the ultimate solution. As a result, five distinct classes of land titles are intermingled on most of the reservations. This situation is fully discussed in another section (pp. 278–285) and therefore will not be repeated here. It should be said, however, that the resultant land-ownership pattern has been one of the major obstacles to the practice of proper range management on Indian lands. Progress in recent years has been encouraging and should be more rapid under the broad authority vested in the Interior Department by the Wheeler-Howard Act of 1932.

[18] This paragraph refers entirely to range lands and should not be construed as a criticism of the management of State forests and parks, which in some instances is very creditable.

REMAINING PUBLIC DOMAIN

Beginning late in the nineteenth century, a few farsighted individuals began to realize that for certain lands private ownership was neither feasible nor desirable. As a result, partly owing to public pressure but more largely to the political astuteness of certain conservation leaders, a large area of the remaining public domain has been withdrawn from all forms of entry and reserved for public management. Chief among these reservations were those creating the national forests, national parks and monuments, and power-site withdrawals. Also a great area has been reserved for such special purposes as Indian reservations, reclamation sites, stock driveways, and mineral reservations. Although there is a material amount of overlapping as between various reserves, their general extent, as recorded in the 1934 report of the Secretary of the Interior, is shown in the following partial tabulation:[29]

	Acres
National forests	138,120,193
National parks and monuments	8,692,196
Indian reservations (estimated net)	56,676,585
Military, naval, and similar reservations (approximately)	1,000,000
Bird and game refuges	1,512,371
Stock driveways	9,771,396
Reclamation withdrawals	20,208,621
Water power reserves	5,147,654

As a residue from the combined effects of the land-disposal policy on the one hand and the reservation policy on the other, we still had, on July 1, 1934, 165,695,479 acres of unappropriated and unreserved public domain, of which 162,188,181 acres were in the range country. For the purposes of this section grazing districts as shown in table 45 are considered to be public domain.

TABLE 45.—*Public domain areas in the range States, included and not included in "grazing districts"*

State	Included in grazing districts	Not included in grazing districts	Total, public domain
	1,000 acres	1,000 acres	1,000 acres
Arizona	1,805	11,268	13,073
California	1,872	13,804	15,676
Colorado	6,439	676	7,085
Idaho	4,192	6,805	10,997
Montana	3,892	2,018	5,910
Nevada	7,965	43,194	51,179
New Mexico	8,770	2,875	11,649
Oregon	9,561	670	10,240
Utah	20,045	1,966	21,983
Washington		710	710
Wyoming	1,543	12,528	14,071
Kansas, Nebraska, North Dakota, Oklahoma, South Dakota, Texas		825	825
Total	65,523	96,665	162,188

On June 28, 1934, the Taylor Grazing Act, which provides for some degree of public control of grazing on 80 million acres of the public domain, became a law. Although the restriction in acreage

[29] Fig. 62 shows the location and extent of some of the more important classes of federally owned or controlled land.

still leaves more than 85 million acres of Federal public land without provision for control, it seems inevitable that some sort of management will be provided very shortly. This can be provided through amendment to the Grazing Act to include the entire area, through a division of the area between this and other agencies in the interest of consolidation and conservation, or through a combination of these measures. Consideration of the good and bad features of the Grazing Act will be found elsewhere. It is necessary here to present the effects on the land pattern which this immense acreage of predominating range land exerts and to describe in some detail its condition and the reasons therefor.

The public domain of the West is made up of remnants left after careful culling by many agencies. The homestead, desert homestead, and grazing homestead laws eliminated much of the best of the natural range area. State, railroad, and other grants, with their provision for lieu selection of indemnity land, still further reduced the average quality. The national forests, Indian reservations, reclamation withdrawals, and so forth, each have absorbed grazing land better than that which remained. Clearly the residue of 165,695,479 acres consists of the least desirable of the original 1,442,220,320 acres. Certainly, it includes the poorest 10 percent of the lands west of the Mississippi River.

Not only is the land poor in quality but its geographic distribution often makes administration difficult. Except those semidesert, or extremely low-value areas where there was little demand for the land, it is scattered in units too small to administer separately and badly intermingled with other ownerships. As has already been emphasized, absolute lack of proprietorship on the public domain resulted in the worst kind of abuse through overgrazing and use during improper seasons. Wherever there is any public domain used as open range, it is in virtually every instance in a more advanced state of depletion than similar land under any other form of ownership.

Along with forage depletion has gone, more often than not, the top soil, and along with it the soil fertility. The forage and soil resource is generally so badly deteriorated that the land has lost not only its grazing values but also its ability to regulate run-off and prevent erosion.

Reasons for Delay in Adopting a Constructive Range-Land Policy

Failure to correct the evils of our Federal range-land policy is hard to understand. As early as 1878, Lieutenant Powell, then Chief of the Geological Survey, after a rather thorough field examination, prepared a report on the necessity for revising our land laws to fit conditions in the semiarid West. His report (*107*), with remarkably clear foresight, pointed the way for future action. He recognized the desirability of combining range and irrigable land, of the protection of water holes for widest possible use, and of preventing nonirrigable lands from going into crop agriculture. No action was taken.

In 1898 the American National Livestock Association, well knowing that the range resource was being destroyed, passed resolutions

asking that the public domain be given protection from overgrazing. No action was taken.

In 1903 President Theodore Roosevelt, fresh from his experiences in Dakota and Montana, realizing keenly the impaired condition of the range resource, appointed a Public Land Commission to investigate and report. This Commission after much testimony and travel reported not only what would happen but what had already happened. It recommended, as suggested by many progressive stockmen, that the remaining public domain be withdrawn from entry and placed under Federal administration with provision for homesteading after careful land classification. No constructive action was taken. In due time additional laws were passed designed to facilitate rather than prevent further damage.

In 1930 President Hoover appointed the Committee on the Conservation and Administration of the Public Domain. Another study was made and another recommendation for placing the public domain under administration. In this instance primary emphasis was placed on transfer of the land to the States where they so desired and where proof of ability and intention to protect the resource could be given. Mineral rights were to be reserved to the Federal Government. In those States not caring to assume the heavy responsibility of rehabilitating these run-down lands, administration by the Federal Government was recommended. Also the remaining forest lands, high-value watershed lands, and units desired to block out administrative divisions, were to be added to the existing national forests. It is probably fortunate that several of the recommendations of this report were never translated into law.

Finally in 1935 after a half century of delay and failure to act realistically on the public-domain range problem, and after untold damage to the range and to the livestock industry had resulted, less than half of the remaining public domain was placed in the way of administration. The remainder, together with nearly 25 million acres of unperfected homestead claims, remains a "no man's land."

Why the delays? The reasons are obscure and may be conflicting. First of all has been the ever-present fear of oppressive bureaucracy. The idea of placing in the hands of some governmental agency the final say as to the use of lands which heretofore have been used without hindrance, was distasteful to many of the pioneer American stockmen. Perhaps in no business has the spirit of rugged individualism been more strongly displayed. From the days of the Texas trail herds on down to the present depression, the business has been highly individualistic. The motto has been, "Let the best man win." As a result, the stockmen were unable to unite on a solution behind which they could mass their full strength.

The State rights argument has likewise been used to prevent action. Even though the management of State lands more often than not has been on a political basis with no apparent regard for the permanence of the resource, there has been a strong following for transfer of the public domain to the States. That, in their present depleted condition, management and rehabilitation of these lands would constitute a liability rather than an asset, seems not to have been realized. The fact that some receipts were being obtained from lands already in State ownership easily led to the

assumption that the ownership of the public-domain lands would increase this revenue. Partisan politics, especially within some of the States concerned, has made good use of the State rights principle at the expense of the perpetuation of the range and watershed resource.

Another feature in the delay has been a possible advantage which the stockmen have seen in keeping the situation such as to afford an opportunity to play one form of Federal control against another. That this is true is evidenced by the situation today when the division of Federal responsibility between two departments is being so used.

Always, of course, the question of the fee to be charged for use of the range has played a part far beyond its true importance. The cost to the stockman of equitable fees, as against insecurity in the use of range, losses from overstocking of ranges, and damage which results from erosion and unregulated stream flow from such areas, should be quickly accepted as the only reasonable alternative.

Transcending all of these, however, has been the lack of inspired, aggressive leadership. Reports have been made, laws have been drafted and recommended; action to correct abuses of existing laws has awaited definite and inescapable mandate from Congress; but the "punch" required to convert reports and recommendations into established policy has not materialized. Always the solution has been diluted by the tradition for land disposal and passage of title to private ownership. Had there been inspired leadership, such as Gifford Pinchot displayed in putting into effect a constructive conservation program for forest lands, the unreasonable delays could not have continued. Partisan politics, adherence to outmoded precedents, suspicions of bureaucracy, pure inertia, unwillingnesses to face facts, and lack of appreciation of the worth of the forage resource—none of these nor all together would have been able to obstruct, as they have done, so obvious a course of action on behalf of the public welfare, if such leadership had developed.

The Effects of Past Land Policy

Effect on present range-land ownership

The ownership pattern of range lands within the region where the raising of range livestock must be the major industry has gradually become exceedingly complex and confusing. In general, our land-disposal laws were so drawn as to keep ownership units to a small size and, except in the case of the national forests, to make no provision for continuing use of sufficient additional range to support a home unit. That one purpose back of this type of legislation was the prevention of monopoly in land ownership and control in no way alleviates the situation which we now face.

The only laws which were so framed as to facilitate the control of range land in units of manageable size were those providing for certain Federal reservations and those which authorized the exchange of private or State lands within these reservations for lands in the unreserved public domain. The national forests, and more recently the grazing districts, have for one purpose the consolidation of ownership for better management. Yet, even in this type

of ownership, management is made more difficult by the titles which passed from the Government before the creation of the reserves. Railroad grant lands, State school sections, submarginal homesteads, and other private land within the boundaries present a problem, the solution of which will not be easy.

A considerable part of the public domain coming within the grazing districts is in such small tracts and so badly scattered that real constructive range management can be had only when and if the adjoining areas can be included under the same administration. Figure 62 gives a generalized picture of the area included within the various Federal reservations and on which grazing use can be controlled in varying degrees. Actually, much of these areas is still in the patchwork pattern shown in figures 63 and 64.

FIGURE 63.—OWNERSHIP PATTERN IN COLORADO.

Characteristic of many a western range county, the actual pattern is even more varied than here indicated, since "Corporate groups", "Nonresident", and so on, may include several different owners in any one block of land so labeled.

FIGURE 64.—RANGE OWNERSHIP IN MONTANA.

Such "crazy quilt" patterns of ownership as shown in this small area in Montana and in fig. 63 encourage and accelerate range depletion by offering a serious handicap to good range management. It is obvious that units of ownership or control and of management practice must bear some relation to each other.

Through the operation of lieu selections, States and railroads in selecting indemnity lands have been enabled to effect a considerable amount of consolidation. A large part of these selections, however, has been in regions where timber values were high and where grazing values were correspondingly low if not entirely absent.

Outside the boundaries of the Federal reservations we find a confusing ownership picture. It has been well described by R. R. Renne, of the Montana Agricultural Experiment Station in a recently written unpublished manuscript. The description is typical of much of the eastern two-thirds of that State.

> Thousands of tracts owned by individuals residing all over the United States; thousands of small farm units interspersed among grazing areas and other ownerships; a large portion of the remaining public domain occurring in isolated, disconnected tracts; state holdings scattered, usually including the sixteenth and thirty-sixth sections of each township; thousands of acres of county land, taken through continued tax delinquency, and occurring haphazardly in small units; railroad lands making a checkerboard effect in some areas, being much more scattered in others; insurance company lands scattered thinly here and there; investment and mortgage company holdings strung out in a disorderly fashion, representing parcels out of larger blocks not yet sold; lands foreclosed by land banks and commercial banks occurring at random here and there * * * such is the pattern of ownership established under a policy of "laissez faire", free individualism, and planless settlement. With such a pattern economic instability, overgrazing, and general misuse of the land occurs.

The above description by one who has spent several years in an intensive study of the land-ownership problem in our western range country is not overdrawn. Figures 63 and 64 present graphically the ownership pattern of typical areas in Montana and Colorado. Actually the ownership in these areas is immeasurably more complicated than here shown, as is evident in the necessary grouping on these maps of several ownerships in certain of the classes. For example, Federal ownership may include land under the jurisdiction of several departments or bureaus; corporate ownership includes not only railroad land but that of all banks, investment houses, insurance companies, and all other incorporated entities; and private ownership is widely distributed among both residents and nonresidents. Need more be said concerning the seriousness of multiplicity of ownership in its effect on range management in a predominantly range country where it takes from 3 to 15 acres to support one cow for a month?

Our land policy has had equally serious effects on the resultant land use. Generally the land-disposal laws have not provided for adequate land classification before settlement was permitted or title was passed. It is true that certain laws, specifically the stock-raising homestead law, did so provide, but in practice the classification was in no sense adequate and did not protect the settlers from an uneconomic land selection. Land-hungry applicants, encouraged by publicity departments of railroads, real-estate locators, and local chambers of commerce—with or without previous farm or ranch experience—were permitted to select at random their quota of land. Title was allowed to pass with little regard to the suitability of the land for the purpose intended.

To say that the application of the 160-acre homestead law to the nonirrigable lands of the semiarid West was disastrous is no overstatement. The dry-farm wheat belt of the short-grass plains was settled under this law. The effect of the World War with its resultant peak prices for wheat and other farm commodities, coming during the period of settlement, has been described in an earlier section.

At this time, too, the dry-farm region was favored with more than normal precipitation for a period of several years. As one result of this coincidence literally millions of acres of the best natural range was turned under with the plow. Then the war ended. Wheat surpluses built up. The dry years came on. A large part of these wheatlands that once were range were abandoned.

While no reliable statistics as to the extent of abandonment are available, it has been estimated that more than 20 million acres is not too high a figure. In Montana, according to unpublished estimates, nearly 5 million acres, and in Washington more than 1 million acres of such land present a major problem. Homesteads patented under the various laws, State lands leased for agricultural use, railroad lands, and homesteads not yet proved up on, all suffered in varying degree.

The dry-farm wheat lands of many parts of the West today present a discouraging picture. Immense areas which once supported a fine stand of grama and buffalo grass now grow little except worthless weeds. Literally thousands of homes, cheaply constructed to be sure, stand dilapidated and abandoned. Other hundreds of homes still occupied plainly show a degree of poverty seldom equaled in our city slums. Schoolhouses are abandoned, or if still used, show the results of an attempt to continue public education at a cost per pupil greatly exceeding that in the more prosperous communities. Local governments are deeply involved in financial difficulties, if not in fact actually bankrupt. It is thus that we pay the price of a land settlement that ignores sound planning in the use of land.

The extent of tax delinquency in the range area is not now known. Comparable figures for the entire area have not been collected. Sample range counties in several States are, however, available to indicate the extent to which ownership has reverted to the public. According to R. R. Renne, the county governments of Montana in 1934 owned 2,526,349 acres (excluding lands within the boundaries of incorporated municipalities, highways, rights-of-way, etc.) Several times as much was delinquent 3 or more years and subject to tax deed, but because of recent tax moratorium legislation title had not been perfected.

Table 46 indicates for Montana, for which tax data are available, the building up of delinquency during recent years. Although it is impossible to segregate natural range from cropland, it is well known that delinquency is worst on dry-farm wheatland which has been abandoned for cropping. The counties in which delinquency is most prevalent are those in which range livestock and dry farming have predominated. In the final analysis, tax delinquency of abandoned dry-farm land is a range problem. It is only through rehabilitation for range use that these lands can again be made to produce satisfactorily. It is significant that even during the prosperous years delinquency was serious. In 1928, as shown in table 47, more than 15 percent of the range and cropland was so listed and by 1933 this had increased to more than 40 percent.

TABLE 46.—*Progress of tax delinquency on range and cropland in Montana*

Year	Total area	Delinquent—		
		Lands	Properties	Owners
	Acres	*Percent*	*Number*	*Number*
1928	93,043,680	15.11	30,203	25,975
1929	93,433,343	17.11	34,179	29,176
1930	93,205,504	23.30	44,283	34,050
1931	93,271,338	35.44	62,234	46,575
1932	93,313,230	41.49	72,901	54,555
1933	93,241,984	40.24	68,653	52,366

TABLE 47.—*Tax delinquency, by years, in one Colorado county*

Year levied	Land					
	Irrigated	Grazing	Dry farm	Meadow	Coal	Total delinquent
	Acres	*Acres*	*Acres*	*Acres*	*Acres*	*Acres*
1922	204,023	695,371	400,223	3,260	992	1,423,869
1931	206,075	695,404	442,008	3,142	808	1,305,229
1930	166,234	728,977	365,113	3,240	720	1,077,283
1929	139,057	690,907	307,755	2,891	733	1,070,743
1928 [1]	144,264	692,342	280,289	3,139	800	1,020,834
Total	919,373	2,907,691	2,000,485	15,491	3,909	5,897,759
Average	183,175	581,400	410,097	3,098	782	1,177,552
Percent	15.5	49.4	34.8	0.2	0.1	100.0

[1] Even prior to the depression, tax delinquency in this county was a serious problem, as it was in adjoining States also.

That the above situation is not peculiar to any one range State is shown in the Colorado yearbook for 1933–34 on page 277. In 1932 nearly 61 percent of the privately owned farm and ranch land (approximately 21,760,000 acres) was delinquent for general property taxes. In 1928 the percentage of delinquency was only 30.4 percent and the acreage involved was 10,679,084 acres. That delinquency in this instance was worst on grazing land and dry-farm lands is shown by table 47, which is based on information for one typical range county. It is significant that 49.4 percent of the delinquency is on range land, and 34.8 percent is on dry-farm land which should have remained in grass, while only 15.5 percent is on irrigated cropland. Thus 84.2 percent of the tax delinquency in this county is on land for which grazing would seem to be the highest use.

The tax delinquency situation is likewise serious in the range livestock counties of eastern Oregon. As of March 1, 1934, 12 eastern Oregon counties in which the range industry is predominant or codominant with lumbering, owned 674,450 acres of land. Abandonment of land to the counties for unpaid taxes was far less in arable agricultural counties than in the grazing counties. In three range counties the acreage of land on which taxes were delinquent 3 or more years, but which had not gone to county ownership, increased from 187,393 acres in 1928 to 1,092,731 acres in 1933. Although an exact division between range and submarginal farm land is not possible, the delinquency situation is known to be very serious for both classes of land. While additional data from sample plot studies in other States are available, those given are sufficient to establish the fact

that on range land and especially on abandoned dry-land tax delinquency is a serious problem. Probably the latter class of land is in greatest distress.

The period of rapid homesteading and expansion of wheat production brought large increases in population. Towns were organized; school districts were created; counties were divided; road and highway districts came into being; new local taxing bodies were initiated on every hand. Thus there developed a local government pattern designed to serve a relatively dense population. That it was expensive mattered little during the boom days. Bond issues were easy to float. Today, with the population reduced in number (Montana suffered a 20-percent reduction in the number of farm units between 1920 and 1930) and with a full realization that, after all, the land was intended for grass, the problem of developing a suitable local government is acute.

The need for high-quality, efficient government is immeasurably increased by the economic difficulties now facing the range counties. The tax base upon which to finance good government is decreasing and with each additional tax abandonment the loan on those still paying becomes heavier. The inclination to "let the county have the land" spreads to owners of better and better land. The solution does not rest in providing "cheaper" government but in providing better and more efficient government.

Part of the answer may lie in consolidations of small governmental units and in careful long-time planning and rehabilitation. Besides focusing the attention of the community on the problem of good government, consolidation should, through reduced overhead, lower the costs, although it must not be forgotten that it will not reduce the combined bonded indebtedness of the units consolidated. Thus, through elimination of some of the local governments, there is a definite possibility that the functions of government may be better performed and at less cost.

Within this picture of tax delinquency one other important factor requires especial consideration. In most of the States lands upon which taxes are unpaid ultimately pass to the counties or remain in the twilight zone of no ownership until sold. Hence we are building up in the range country a "new public domain." Too often, under pressure for increased county revenue, and in some instances in accordance with State laws, these lands are sold to the highest bidder, only to revert again for nonpayment of taxes when the new owner realizes their true worth. Thus, these lands shift between county and private ownership without regard for their income-producing value and in a status to encourage improper use. It is obvious that these lands are submarginal for private ownership in the use to which they have been put. It is equally clear that under present conditions the counties cannot afford to own them. Much range land has been depleted to the point where it is now unable to carry its share of the cost of government. The abandoned crop land, although it was no doubt once first-quality range, has come back to public ownership with the forage cover destroyed by plowing and now supporting a sparse stand of vegetation of low value for grazing in place of the original fine perennial grasses.

That revegetation by natural means will require an excessive period of time is shown by a recent (unpublished) study by E. W. Nelson

of Montana University Forest School. Table 48, which is taken from his report, shows that during the first 5 years after abandonment 85.7 percent of the cover consisted of worthless and unpalatable species. Only 7 percent was grass. Even 16 or more years after abandonment it was found that more than 29 percent of the cover was made up of unpalatable species, with only 45.4 percent in the grass group. It should be noticed, further, that only 3.4 percent of this grass cover was blue grama, whereas on adjacent unbroken grasslands 36 percent of the vegetative cover is accounted for by this most excellent species.

TABLE 48.—*Occurrence of native species on various types of land in Wheatland County, Mont.*

Species	Scientific name	Native grassland	Abandoned plowed land			
			1-6 years	6-10 years	11-15 years	16 years and more
		Percent	Percent	Percent	Percent	Percent
GRASSES AND GRASSLIKE PLANTS						
Blue grama	Bouteloua gracilis	36.0	0	2.0	2.0	3.4
Bluestem	Agropyron smithii	7.8	4.0	12.0	12.0	18.0
Needle and thread	Stipa comata	12.5	1.0	12.5	20.0	14.0
June grass	Koeleria cristata	4.0	0	1.0	2.0	(1)
Native bluegrass	Poa spp.	(1)	0	(1)	(1)	(1)
Other grasses		3.0	0	4.0	4.0	3.0
Dryland sedges	Carex spp.	12.0	(1)	1.0	2.0	2.3
PERENNIAL AND BIENNIAL WEEDS						
Palatable		0	1.6	2.1	5.4	2.1
Unpalatable		4.6	11.6	12.1	8.0	10.3
ANNUAL WEEDS						
Russian thistle	Salsola kali	2.0	70.0	28.0	16.0	12.0
Other annuals		2.3	2.3	4.3	2.4	1.0
BROWSE						
Silver sage	Artemisia frigida	3.0	5.7	12.6	12.3	17.2
Snakeweed [2]	Gutierrezia sarothrae	2.3	1.6	5.1	6.9	4.0
Phlox [2]	Phlox nimoides	2.6	0	1.3	(1)	3.7
Cactus	Opuntia polyacantha	1.0	0	0	0	1.0
Total		100.0	100.0	100.0	100.0	100.0

[1] Less than 0.5 percent. [2] Considered half shrubs.

Nelson's conclusions as to rate of natural rehabilitation of plowed and abandoned dry farms are substantiated by those reached by Shantz (*125*) from a study in Colorado in 1911. In the Escalante Valley in southwestern Utah, George Stewart found that the rate of recovery of lands last plowed in 1913 was very much slower than that determined by Nelson in Montana.

It is seriously questioned whether private owners can profitably hold a class of land which shows so little improvement even after many years of abandonment from cropping. Its rehabilitation within a reasonable period seems generally to be dependent on artificial reseeding. Just how private owners and underfinanced coun-

ties can undertake a wholesale program of artificial reseeding in a region where the climate makes the undertaking extremely hazardous and until the costs of such treatment can be reduced to much less than the value of the land so treated has yet to be answered.

The problem for the rehabilitation of badly depleted range land and the restoration of abandoned dry farm land seems to be one for a strong unit of the Government to undertake.

EFFECT ON THE RANGE RESOURCE

The complex ownership pattern of range land which has been built up and the deterioration and destruction of the range resource which has accompanied this process presents a major problem to the livestock industry, dependent communities, the States, and the Nation. As is shown in discussing integrated agriculture, crop farming and range use are inseparable parts of the agriculture of the Western States. The extent to which either use is successful depends in large part on the degree to which the other can be made to contribute toward it. Clearly close coordination is essential to the permanent and continuous prosperity of the integrated agriculture.

Coordination in use is equally essential to the conservation of the high public values which much of this land carries. High-value watersheds, critical erosion areas, tracts badly needed for recreational use, and key areas for game use have been passed to private ownership or abusively used without regard for their need for these special services.

One of the essential features of sustained-yield management is security in the right to use the forage resource which may properly be harvested from the land. That such security is impossible under an ownership pattern such as has been previously described seems clear. One small area sufficient for even 150 head of cattle or a small band of sheep may be divided in ownership between so many individuals, corporations, and agencies that planning for future use is impossible. The logical user of the range is never sure that some less dependent competitor will not legally invade his range through purchase or lease of part of the area. Also, the situation which now exists lends encouragement to the "coyote sheep herder", who, by the lease of small, widely separated areas, combined with his equal right to use such public domain as may remain, feeds his flocks in trespass on areas which have been held for special seasonal use, or which purposely have been lightly grazed as a range rehabilitation measure. Thus the usual result is to consider only the present and get the last blade of grass every year. Under such treatment range depletion has been serious and will continue.

The effect of dry farming on the range resource has already been discussed. The native range forage has been destroyed and has been replaced by plant species of little or no forage value. Natural rehabilitation will be extremely slow. Unfortunately, these dry farm lands are often intermingled with unbroken range lands, thus reducing the average carrying capacity of entire units to an extremely low level. Ownership is widely distributed, and tax delinquency is most serious. Thus, in regions where unsuccessful dry farming has been practiced, the problem of range rehabilitation is particularly

difficult and is made more complicated by the land-ownership situation which exists.

One of the most unfortunate results of the land policy which has been followed in the West is the extent to which it has encouraged overinvestment in land, and in turn abuse of the range. As homestead entries were allowed and patents were issued the stockman who had previously used the range borrowed from the banks to buy out the so-called settlers and gave a mortgage on his enlarged holdings as security. The increase in owned range did not increase the area or productiveness of the range unit which he had previously used free of charge as public lands. To meet taxes and interest payments on the enlarged ownership, the stockman usually found it necessary to increase the size of his flock or herd. The result, almost inevitably, has been overgrazing and range depletion.

Under the conditions which have been described it is to be expected that ranges generally have been depleted. The extent to which depletion has gone under the various forms of ownership and control should be one guide to future action. It is significant that in every major forage type the national-forest ranges are now in better condition than those under any other form of control. At the other extreme, as might be expected, is the public domain, where no administration has been given to range use.

The Problems Which Arise From Land Ownership

The tangled and illogical ownership pattern which has arisen from the lack of constructive land policy as previously shown, has had and still has a serious influence on the perpetuation of the range resource. Four problems stand out as the major features which require solution.

SIMPLIFICATION OF OWNERSHIP PATTERN

Clearly, such intermingling of ownerships as is illustrated by figures 63 and 64 is too great a handicap on the development of good range management. The situation is made immeasurably more acute by the fact that a very high percentage of the lands is held by absentee owners who have no personal interest in the community welfare other than that of obtaining a return on their investment.

Another large segment of potential range land widely diffused in ownership has been effectively lifted out of production by an unsuccessful attempt to grow dry-farm wheat. The economic rehabilitation of such land for productive use depends in large part on assurance for future good management of the property. Simplification of the pattern will be one incentive to better treatment.

State legislation to facilitate consolidation in some form of public ownership, the formation of cooperative grazing districts for administration of certain units, and active participation by the Resettlement Administration of the Federal Government should all be considered as possible aids to the solution of this problem. A more logical ownership pattern is fundamental to permanent range rehabilitation and maintenance.

DIVISION INTO ECONOMIC UNITS

The distribution of the grazing resource in such a way as to avoid monopolistic tendencies, without dividing it up in such small units as to destroy its social value, is another major problem. Ideally and ultimately the range resource will probably contribute most if made to support the maximum number of satisfactory home units. This does not necessarily mean individual ownership of sufficient ranch and range property to support the number of stock required to meet this objective. The system of distribution of grazing privileges in effect on the national forests offers one solution. Under this system dependency of the outfit on the use of range forage, the commensurability of owned land on which supplemental feeds are raised or which is used as winter range, and the number of stock owned each are considered.

The livestock requirements for an economic unit will vary greatly. In regions where range livestock is the sole means of support, the ideal family unit may call for about 150 to 200 head of cattle or a small band of sheep. Where diversified farming is practiced, provision to graze only a few head of stock may be essential to supplement the other farm income. In certain regions where successful management is contingent on running a large outfit it may be entirely proper to recognize such ownership. Always the effect of size of outfit on the cost of producing meat, wool, and hides must be given fair consideration. The controlling principle in each decision should be the support of the maximum number of people at an acceptable standard of living. If this objective can be approached, the cost of rebuilding the depleted ranges can be justified.

TAXATION

One of the problems of range-land ownership is that of taxation. The extent of tax delinquency in the range country establishes the fact that, in their present run-down condition, much range land cannot carry the load. It is significant that, generally, on those properties where good range management has been practiced the taxes have been paid. Certainly a part of the solution of the range-land tax problem rests on rehabilitation for maximum production, but the ranges are not yet rehabilitated and taxes are payable each year.

Range lands must, as a matter of course, pay their full share of the cost of good government. Their failure to do so in recent years is so greatly influenced by the effects of the lack of good management and by the delinquency of intermingled lands improperly used for crop agriculture that thoroughly reliable conclusions are impossible. It seems probable that the taxes on these lands are disproportionally high in terms of real income value. This much is clear. A comprehensive analysis of the tax problem on the range area should be undertaken, and in the meantime serious consideration should be given to the possibilities of revamping the local government organization to fit the population pattern which exists. Certainly some means must be found to prevent range lands from being given the abusive treatment commonly accorded to tax delinquent or reverted property.

RESPONSIBILITY FOR RESTORATION

Finally, regardless of who owns the land, full recognition must be given to the fact that range forage is an agricultural crop. That this fact has not been appreciated is evident. A large part of federally owned range lands are administered outside the Department of Agriculture. State and county lands have been administered by agencies whose primary responsibility is revenue collection, and the State agricultural services have used little if any. Private lands, in most instances, have been "mined" rather than cropped for forage. Until such time as the natural laws of crop production and plant growth are followed in range management, restoration is not to be expected.

Correction of the bad range-management practices will be aided by placing responsibility for range restoration with those agencies engaged in the solution of agricultural problems. Not only is this true for Federal and State lands but for large tracts in corporate ownership as well.

RANGE CONSERVATION THE EXCEPTION

By C. L. Forsling, Director, Appalachian Forest Experiment Station; Fred P. Crowemiller, Assistant Regional Forester, California Region; Percy R. Mills, Forester, Northern Region; Arnold R. Standing, Range Examiner, Intermountain Region; Alva A. Simpson, Associate Director, Plains Shelterbelt; and Rex King, Assistant Regional Forester, Southwestern Region

The western range picture is not entirely unfavorable. There are areas on which action has been taken or is in course of being taken, to stop depletion, improve existing conditions, and stabilize the use of the range. In the national forests is found the greatest single attempt to turn back the tide of depletion and to undertake planned use of the resources. Progress is being made on the Indian reservations. Action has been started in the grazing districts on 66 million acres of what until recently was open public domain. Here and there in the West are found privately owned range lands which have been carefully utilized and the forage resources wisely conserved. These instances of deliberate management are guideposts pointing the way toward a sounder range livestock agriculture.

The National Forests

Of the present area of approximately 133,875,000 acres of federally owned land in the national forests of the western range States, about 82,538,000 acres, or 62 percent, of the total is used for grazing of domestic livestock. Upon these lands approximately 1,400,000 cattle, 30,000 horses, and 6,152,000 sheep and 9,000 goats are grazed regularly during several months of each year.[20] These permitted livestock, which represent 12 percent of all the cattle and 23 percent of all the sheep in the 11 western States, are owned by more than 25,000 farmers, settlers, and ranchers, most of whom reside in or near the forests.

The national forests represent the initial effort of the Federal Government to undertake on a major scale the management of land resources which it was in the general interest to retain in public ownership. Extensive areas of the range which was included had already been seriously depleted by the free-for-all use which had gone on for several decades prior to the establishment of an administrative agency. The situation in many respects was not unlike that on the open public domain today. The mad scramble for range and the competition between the large livestock operator who had preempted the open range and the home builder who was endeavoring to get a start was at the expense of the grazing resources and the orderly development of struggling new communities.

Although the guiding motive in the establishment of the national forests was the conservation of timber and the protection of water-

[20] Exclusive of calves under 6 months and of lambs. The average grazing season for cattle is 5.7 months, for horses 5.5 months, for sheep 4.3 months, and for goats 5.7 months.

sheds,[81] conservation of the other resources was implied, and the forage crops produced on them have received equal consideration in protection, development, and use along with all other resources. The basic aim in the management of these lands has been to develop sustained yield and to make all of the resources contribute in the fullest degree, consistent with the broader public needs, to the sound social and economic development of the dependent population. On the whole, it was an attempt toward planned use of land and a challenge to the laissez-faire doctrine in land occupation and use in the United States.

Today, after 30 years of administration under the Department of Agriculture, not all of the national-forest ranges have been restored to their virgin capacity, but real progress has been made. Wholesale depletion has been checked and marked recovery is the rule. The national-forest ranges, on the whole, as shown in table 49, are in approximately 70 percent of virgin condition. This figure compares favorably with figures elsewhere presented—of 33 percent of virgin condition on the grazing districts and public domain and 49 percent on private range lands.

TABLE 49.—*Degree of depletion of virgin range in plant types on the national forests*

Plant type	Total area[1]	Moderate depletion (0–25 percent)	Material depletion (26–50 percent)	Severe depletion (51–75 percent)	Extreme depletion (76–100 percent)	Average depletion
	1,000 acres	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*
Tall grass	202	100				12
Short grass	993	40	48	12		20
Pacific bunchgrass	1,714	20	46	25		37
Semidesert grass	1,636	3	49	39	10	53
Sagebrush-grass	3,657	11	68	20	1	40
Southern desert shrub	96		51	8	41	60
Salt-desert shrub	300	40	49	9		26
Pifion-juniper	13,811	25	41	30	4	41
Woodland-chaparral	713	2	70	28		44
Open forests	64,785	55	37	7	1	26
Total and average	87,954	46.5	40.0	12.0	1.5	30

[1] Includes acres of usable range closed to grazing for various purposes.

Earlier presentation of trends of depletion has shown that during the past 30 years the average trend has been one of improvement on 77 percent of the national forest range area and on only 5 percent has there been an appreciable decline. During the last 5 years, however, owing to drought and depression, the improvement trend has been offset by a slightly downward trend on 19 percent of the area. The net improvement may be summarized in one figure for the period from 1910 to 1934—forage production on the present usable range on the national forests has increased 19 percent.[82]

[81] For a discussion of the timber resources and watershed values in the national forests, see A National Plan for American Forestry (34), pp. 173, 298.

[82] The number of livestock grazed on the national forests in terms of animal months of use was actually reduced about 7 percent between 1910 and 1934. However, during that same period a net area of approximately 10,000,000 acres, mostly grazing land, has been excluded from within the national forests. Approximately 2,250,000 acres, most of it the very best grazing land, has been alienated under the Forest Homestead Act of June 11, 1906. Grazing capacity amounting to an equivalent of approximately 2,000,000

The net social and economic benefits which have been derived from the policy of administration of the national forests, are more difficult to appraise in specific terms. Nevertheless the benefits have been positive and real. Almost as many livestock are grazed and as many dependent stock growers use the range now as a quarter of a century ago. Forage on national-forest range is more dependable than on any other class of land. Uses for other purposes than for grazing have greatly increased. National-forest ranges to a large degree have been correlated with other classes of agricultural land.

It is proposed to review briefly the circumstances and vital forces which led to the establishment of the national forests and the initial aims and objectives of administration; describe briefly the action taken to implement these aims and objectives and to appraise the net results and existing problems. Such an analysis of accomplishments in the initial experiment with Federal land management may be of significance in further developing a program for future action on all publicly owned range lands.

ESTABLISHMENT OF THE NATIONAL FORESTS

The initial approach to conservation of the range resources was an outgrowth of the concern over the depletion of forests and injury to watersheds. Alarm over forest destruction as a national problem was expressed as early as 1819 (77). There was, however, a long delay before any positive action was taken. In the meantime, legislation was directed principally toward disposal of land. The Secretary of the Interior vainly requested appropriations with which to enforce laws against illegal cutting of timber on the public domain. From 1878 to 1891 there was much debate in Congress over Government timberlands, but no action was taken until the passage of the act of March 3, 1891, which authorized setting apart forest reserves by Executive order out of parts of the public domain whether wholly or partly covered with timber. However, progress was slow for several years after the enactment of this statute and up to 1897, only 19 reservations had been set aside aggregating 18,933,280 acres in area.

Efforts were then somewhat stimulated following the report of an investigation the Secretary of the Interior had requested the National Academy of Sciences to make of publicly owned forest lands. Among other things he asked that investigations be made concerning the influence of forest upon climate, soil, and water conditions. The report of representatives of the Academy dated May 1,

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acres of range is reserved for use by game on the total of over 100 State and Federal game preserves. The extension of tree growth on the 42,000,000 acres of grazed timber land has reduced grazing capacity in an amount equivalent to the withdrawal from grazing use of 4,000,000 acres of good grazing land. Approximately 4,000,000 acres of usable range land have been actually closed to grazing between 1910 and 1934, in the interest of watershed protection, game, recreational use, timber growth, and for other purposes. Thus the total range area available to livestock has been reduced the equivalent of 22 percent during the 25-year period. Since the land eliminated or taken out of use was slightly better than average in grazing capacity the area now being used, in order to take care of the present number of stock, has increased 19 percent in grazing capacity. This does not take into account the additional facts that there has been a very large increase in number of game animals outside the game preserves; that in 1910 there were only 75 lambs per hundred grown sheep grazed and now there are 96 lambs for each hundred grown sheep, that the number of calves under 6 months have increased proportionally; and that, due to improvement in breed and quality, the animals are larger and heavier and therefore each animal now consumes more feed than formerly.

1897, among other things recorded widespread and serious damage to ranges and watersheds by unrestricted grazing (*91*). By June 30, 1898, 30 reserves had been established including 40,719,474 acres. Progress continued to be slow, however, for some years, and meanwhile much timber, range, and watershed land which should have been retained in public ownership passed into private hands.

The fight for conservation took on real life in 1901 under the leadership of President Theodore Roosevelt and Gifford Pinchot. The issue was broadened into a fight for the protection of the interests of the people against monopoly as well as for the conservation of the resources. Big interests had shown their power to grab natural resources, to monopolize business, and to control politics.

The situation with respect to grazing livestock on the range helped to stimulate action. At the opening of the twentieth century livestock production in the West was typically a public-lands industry. It had grown great on free range. Severe competition for use of the range had developed between cattlemen and sheepmen and between them and the homesteader. Nomadic flocks and herds from distant wintering and breeding grounds increasingly swept the high ranges. The "tramp stockman" moved from one region to another, pressing in ahead of the local residents in a scramble to get the feed. The homemaker was ground between the upper and the nether millstones. The whole situation was precarious, chaotic, and in many ways economically unsound. Many of the more powerful stockmen sought ways to establish and perpetuate their monopoly of the range. It all tended to retard settlement and community development. To Roosevelt it was a question of a square deal and economic freedom for the people of the West.

The Roosevelt principles gored the monopolistic ox, and the opposition was expressed in pressure for eliminations of land from the forest reserves and finally in the withdrawal of authority for creating national forests by Executive order in most of the States. For obvious reasons the powerful interests wished to retain freedom from interference. Nevertheless, the fight against monopoly and exploitation and for the protection of public interest for the "greatest good to the greatest number in the long run" was partially successful. During the time Theodore Roosevelt was in the White House, 148 million acres were withdrawn for national forests, bringing the total area reserved up to 194.5 million acres. This placed most of the remaining public timberland and most of the more important watersheds of the West under Government control, and a positive system of administration was initiated. However, the plan for national ranges which Roosevelt had proposed in 1905 (*111*) failed to materialize.

Regulated use of the forest reserves was not authorized until the passage of the act of June 4, 1897. Under this law the first rules and regulations were written which provided that—

> The pasturing of livestock on the public lands in forest reservations will not be interfered with, so long as it appears that injury is not being done to the forest growth, and the rights of others are not thereby jeopardized.

The grazing of sheep, however, was prohibited in all forest reservations, except in Oregon and Washington, where the "abundant rainfall of the Cascade and Pacific coast ranges make rapid renewal of herbage and undergrowth possible."

There was almost no development of conservation policies. The major function of the General Land Office of the Department of the Interior, which had most of the responsibility for the forest reserves, was the administration of the homestead and other land-disposal laws, a function hardly compatible with the development of a conservation policy or organization. The tenor of the manual of regulations of April 12, 1902, for example, was that of legality and minimum carrying out of the law. Officials of the Land Office in Washington had no first-hand knowledge of the reserves. Business was largely handled from Washington and great delays were encountered. The instructions to the public were that—

> when the applicant fails to hear of his application in a reasonable time, say 30 days, he should address letters both to the Supervisor and to the Commissioner of the General Land Office, Washington, D. C.

Due to limited authority and divided responsibility, the mechanics of administration were seriously hampered by the resulting "red tape" which greatly annoyed the people of the West who needed to use the resources of the forest reserves.

Appointments to administrative positions on the forest reserves under the Department of the Interior were principally political. Not until December 17, 1904, through the efforts of the Society of American Foresters and other organizations, was the personnel placed under Civil Service. As would be expected under a system of political appointments with no sense of security in office, low salaries and little chance for promotion, well-qualified men were discouraged from seeking employment (77).

There was no technical forest or range-management organization except for a 3-year period beginning in 1901 when the Forestry Division of the Department of the Interior was created. Its purpose was to cooperate with the General Land Office in the administration of the forest reserves. Since such a plan of organization was not basically sound, hostility developed (*28*) and the entire technical force resigned in 1903. With the exception of this group the conservation thought was entirely within the Bureau of Forestry in the Department of Agriculture. There existed the anomalous situation of forest administration in a division of one department and of all the foresters in a bureau of another. President Roosevelt and the Secretary of the Interior urged Congress to transfer the administration of the forest reserves to the Bureau of Forestry in the Department of Agriculture and this was accomplished by the act of February 1, 1905. In 1907 the forest reserves were renamed the "national forests."

AIMS AND OBJECTIVES IN ADMINISTRATION

The broad aims and objectives in the administration of the national forests were laid down by Secretary of Agriculture James Wilson in a letter of February 1, 1905, to the Chief of the Forest Service in which he said:

> You will see to it that the water, wood, and forage of the reserves are conserved and wisely used for the benefit of the home builder, first of all, upon whom depends the best permanent use of lands and resources alike. * * * All land is to be devoted to its most productive use for the permanent good of the whole people and not for the temporary benefit of individuals or companies.

All of the resources * * * are for use, and this use must be brought about in a thoroughly prompt and businesslike manner, under such restrictions only as will insure the permanence of these resources. The permanence of the resources * * * is therefore indispensable to continued prosperity. * * * The continued prosperity of the agricultural, lumbering, mining, and livestock interests is directly dependent upon a permanent and accessible supply of water, wood, and forage * * * (made available) under businesslike regulations enforced with promptness, effectiveness, and common sense.

Local questions will be decided upon local grounds; the dominant industry will be considered first, but with as little restriction to minor industries as may be possible.

Regarding this letter it has been said (*28*):

A careful perusal of the above is commended, not so much because of its terse common sense as because of its continuous existence to the present moment as the standing general orders under which the forest work of the country has gone and still goes forward.

The administration of the national forests provides for the following:

1. *Conservation and use.*—Perpetuation of all of the resources through wise use, protection, and development.

2. *Multiple use.*—Correlation in management and use of the different resources in order to obtain the highest net benefits from the combined resources of the land.

3. *Equal opportunity.*—Protection of the settler and home builder against monopoly and unfair competition in the use of resources.

4. *Integration with agriculture.*—Relating the use of range and other resources on the national forests to farm-grown forage crops, range, and other agricultural resources in a manner to obtain the highest benefits from the several classes of land.

5. *Stability of use.*—Safeguarding livestock agriculture by affording maximum stability in the use of the range resources, consistent with the objects of the national forests.

6. *Cooperation with users.*—Provision for livestock growers, other users, and local governments to have advisory voice in the administration of the national forests which they use.

7. *Local administration.*—A businesslike, decentralized, and technical administration designed and organized to settle local problems according to local conditions without delay.

The first regulations incorporating these basic policies were put into effect on July 1, 1905, except for an advisory voice, which came later. The regulations have been modified from time to time to meet new conditions, for clarification of purpose, and for better definition of their application.

MULTIPLE USE OF RESOURCES

The national forests contain a variety of resources or values, including timber, water, range forage, game, fishing, and recreation. Rarely is there an instance where two or more of these values are not associated on any given tract of land. Some one may be dominant but others are nearly always present in an amount sufficient to require consideration in land management. This association of resources injects the necessity for "multiple use" management—or management which will yield the highest social and economic benefit from all of the resources combined. Accomplishment of multiple use is one of the important objectives of national-forest land management. Obviously

its attainment involves due consideration for local and present-day needs, as well as long-range planning to meet the future requirements.

For example, 43 million acres, or approximately half of the national-forest range, is forest land, where commercial timber production will have to be the dominant use. The number of recreational visitors to the western national forests have increased steadily from more than 3 million in 1917 to over 38 million in 1934. The number of deer, elk, moose, mountain sheep, antelope, bear, and other big game animals on range lands in the national forests increased from 613,000 in 1914 to 1,064,000 in 1934; upland game birds and fur bearers also have increased during this period.

Ordinarily multiple use has been accompanied with only minor sacrifices in the use of any one resource. Exclusion of other uses is unnecessary and undesirable except where the highest public good can be attained in no other manner. Of the total usable area of 87,954,307 acres of range land in the national forests, only 1,410,928 acres, or 1.6 percent of the total usable acreage, has been closed to grazing for highly intensive recreational use; 2,829,441 acres, or 3.2 percent, has been closed for game ranges; 821,156 acres, or 0.9 percent, for watershed protection; 210,344 acres, or 0.2 percent, for protection of timber; and 144,329 acres, or 0.2 percent, for other purposes. The total excluded range amounts to only 6.1 percent of the total usable range area. On the remaining 93.9 percent of land the various uses, including grazing, are coordinated with each other.

One of the chief requirements in multiple-use management has been to foresee the needs and gradually adjust the various uses to meet them. Livestock seldom can be removed on short notice without sacrifice by the dependent user. However, sudden adjustments have rarely been necessary.

ADMINISTRATION OF RANGE USE

CONTACTS WITH THE USER

For prompt and efficient handling of business to promote the solution of local problems upon local grounds, the Forest Service is organized on a basis of decentralized authority. Forest officers are located among the people they serve in order to be constantly in touch with local conditions. The actual job of administration of the range and other resources rests in the forest supervisor and his rangers assigned to each of the 105 national forests in the Western States. The people in the local communities transact their business with either the forest ranger or the forest supervisor. Only remote users must deal by letter or by occasional contact. "Our ranger" is a term applied by many people in western communities in referring to the Forest Service official with whom they deal.

The character of administration and technical nature of the work emphasizes the need for a properly qualified personnel chosen and trained for the duties they have to perform. Practically all forest officers are "career men" who have chosen some line of forestry work as a life profession. Recruited through the civil service, candidates for examinations must show adequate training and experience in forest or range work. The education of the newly pledged forest officer is further advanced by training schools, study courses,

assignments under senior officers qualified to develop younger men, transfers from one type of job to another, and by experience on the job. Assignment to range management is dependent upon aptitude and special qualifications for the work.

Under national-forest policy, users are entitled to exercise freedom in the use of the national forests in accordance with the established rules and regulations, and to be heard on all matters affecting their own or the public welfare. Through the free exchange of ideas most problems are harmoniously settled on the ground.

In order further to facilitate dealing with various local problems, the organization of national-forest users into associations is officially recognized and encouraged. Advisory boards are elected by the association membership and these receive notice of proposed action and have an opportunity to be heard. Over 700 livestock associations have been organized by users of national-forest ranges and many of these local associations are affiliated with the State associations and these, in turn, with national associations which deal with the Forest Service on matters of State- and Nation-wide importance. Grazing boards, created upon the request of the majority of a group of national-forest users, receive suggestions and complaints regarding the administration of grazing, investigate all facts relating thereto, and assist, advise, and consult with forest officers on matters of general interest to the permittees.

Range users, however, are usually outnumbered by others interested in watershed protection, recreation, wildlife, timber, mineral development, and a variety of minor uses, upon which a substantial part of the support of many communities is dependent. The people so involved are as fully entitled to a voice in national-forest administration as are the stockgrowers. Recognition of these interests is also provided for in the national-forest regulations. Counsel and assistance are also invited from city, county, and State governments concerned either directly or indirectly with national-forest administration.

With so many interests involved it becomes the task of the Forest Service, as the public agency concerned, to harmonize conflicts and arbitrate differences between groups or individuals. The Forest Service also has the duty and the responsibility to protect the public interest whenever there is difference of opinion regarding established national-forest policy. Many of the latter cases arise out of the inclination of some users to disregard the requirements for range conservation in order to satisfy their immediate needs. In such instances the Forest Service proceeds on the basis of the best information available and, with due consideration of all the circumstances, adopts the procedure which will lead in the direction of the "greatest good to the greatest number in the long run."

It is the aim of the Forest Service always to settle locally all matters submitted for consideration. However, appeal may be taken successively from the decision of the forest ranger, forest supervisor, regional forester, and Chief of the Forest Service to the Secretary of Agriculture, with whom final regulatory authority rests.

CHARGES FOR GRAZING USE

The collection of a reasonable fee for the use of national-forest range is nothing more or less than the recognition of the common business principle of paying for values received. The intrinsic worth of the forage and the stability afforded the livestock agriculturist in the use of the range have definite values. Not to collect fees from the range users would result in a subsidy to this group as compared to the producer who operates on privately owned or leased range or farm land. The collection of fees is also justified as a means of offsetting the cost of administration and the construction of improvements on the range by the Government, both of which directly benefit the range user. Nevertheless, almost continuous pressure has been brought by the livestock interests using the range to keep the fees as low as possible.

Collection of fees was first provided for by the grazing regulations of July 1, 1906. The principle of competitive bidding was not adopted because it was early recognized that to do so would be disadvantageous to the small operator and lead to instability in agriculture. The minimum charge for summer grazing was first fixed at 5 to 8 cents per head for sheep and 20 to 35 cents for cattle and horses. The regulation prescribing these fees provided that as the conditions of the range improved and the demand for permits warranted it, the charge for grazing would be increased gradually in accordance with the advantages enjoyed by the permittees in the different localities. The last increase followed a detailed appraisal of national-forest ranges begun in 1921 to establish the fees on a parity with commercial rates.

In this appraisal the rates paid on similar leased lands and the cost of owning grazing land, all of which are determined more or less by natural economic forces, were used as a base. Adjustments in the base rates were made for factors affecting grazing value, such as type of forage, topography, weights and losses of livestock, and distance to market. The resultant charges proposed, therefore, varied with the factors inherent in the range. After strong opposition to the general increase by stockmen, the Secretary of Agriculture designated a stockman to review the appraisal who recommended the increase to commercial basis less 25 percent. The Secretary approved the recommendation and ruled that the increase in fees be applied 25 percent a year beginning in 1928 and become fully effective in 1931.

The extreme low prices of livestock in 1931, however, presented a new problem and fees were readjusted to vary from year to year in accordance with the market prices of livestock during the previous year. If the basis is correct the average fee paid over a long period should approximately equal the adjusted commercial rate. Under this readjustment the fees paid into the United States Treasury for grazing on the national forests amounted to an average of $1,359,730 per annum during the 5-year period ending June 30, 1935. Twenty-five percent of the fees are paid to the States in which they are collected, for road and school purposes, and an additional 10 percent was spent for the construction of roads and trails in the national forests.

DEVELOPMENT AND APPLICATION OF RANGE MANAGEMENT

In order to maintain the basic resource and accomplish the highest degree of sustained use of range forage, the Forest Service applies the best known principles and practices of range management. To do so is in the interest of the stockman because it maintains the basic resource upon which livestock production is dependent. It substitutes the policy of stability in the long run for the former practice of exploitation of the resources for immediate gains.

Originally, the individual owner and the Forest Service started even in their attempts at range management—both had to depend on "rule-of-thumb." Meager consideration had previously been given to range management in the United States or elsewhere. Little was known except in the most general way, for example, about the relative value for grazing of the various native range-plant species, their ability to withstand grazing, their requirements for growth and reproduction, the circumstances under which best to use them, the ability of the soil to produce them, and all the other factors which together determine grazing capacity, proper season of use, adaptability of the range to different classes of stock, requirements for sustaining the production of forage, how to maintain the stability and fertility of the soil, and how to maintain desirable conditions of stream flow. Basic knowledge of this character was essential to determine how best to use and maintain the range. It was apparent also that a higher sustained grazing capacity of the range could be attained if there could be developed and applied in a practicable and skillful way a better adjustment of grazing to the natural biological laws governing plant growth, securing a more even distribution of livestock, and a better utilization of the forage.

Various steps were taken to meet this need for a more scientific range management. The assistance and advice of experts in the other Bureaus of the Department of Agriculture were enlisted. Administrative officers of the Forest Service began to make investigations and to build on their experience. Stockmen were called upon freely for advice on practical phases. In 1911 range research was started in the Forest Service. Some of the agricultural colleges and universities, with encouragement from the Forest Service, modified or broadened curricula to provide training in related subjects and to offer courses and conduct research in range management. Thus over the years with aid of research by Federal and State agencies, educational institutions, and tried experience and systemization of methods in the Forest Service, a reasonably comprehensive science and practice of range management is in process of development for improving, maintaining, and utilizing the range resources. Most of the research work is now conducted by the 6 western regional forest and range experiment stations at 12 branch field stations situated in the more important range types both on and off the national forests, and includes studies both in range management and the influence of grazing on soil, timber growth, erosion, run-off, and stream flow. The results of this research have been widely applied on the national forests, and to some extent on other ranges, along the lines indicated in the following paragraphs.

RANGE CONDITIONS NOT LEFT TO GUESSWORK

So gradually may improvement or decline of the range take place that even persons in constant contact with the range are not able by ordinary observation to detect profound alterations. Obviously the sum total of changes over a period of years may be noted, but it may then be too late to repair damage without drastic action. Sample plots on the range actually mapped and recorded at regular intervals according to approved methods, serve as reliable checks less subject to error than human judgment and memory. More than 6,400 of these have been established and are being recorded regularly to detect range trends in western national-forest ranges. Approximately one-third of these are check plots fenced against grazing for use in estimating trends on grazed range. The actual records from these plots serve many useful purposes in settling problems to the satisfaction of both forest officers and livestock owners.

GRAZING CAPACITY

Keeping numbers of stock within the sustained grazing capacity of the range has been one of the most important as well as one of the most difficult undertakings in range management on the national forests. Grazing capacity differs on different ranges and on different parts of the same range, depending upon the character, quantity, and forage value of the vegetation, the character of the soil, the length and character of the growing season, the period of grazing, the extent and degree of depletion, also the ease with which livestock can get over the range, especially as influenced by topography, dense brush and timber, and the distribution of water. Much depends also upon the kind of range management, since the number of stock that can be grazed on a well-managed range will exceed the number on the same range when poorly managed. Grazing capacity on a given range also varies from year to year and over one period of years with another, depending upon vicissitudes of climatic conditions, gradual changes in vegetation, and other factors.

It has been necessary in national-forest range management to keep accurate check on the number of stock actually grazed, the period of use, how closely different parts of the range are utilized each year, the extent to which the range is properly grazed, and whether or not the range is declining, improving, or remaining unchanged. With this knowledge it has been possible to make necessary adjustments from time to time on individual ranges, in order to conform the number of stock to the grazing capacity, and hence to maintain the forage crop which is basic to sustained livestock production.

SEASONAL USE

Correcting improper seasonal use, whereby stock was turned onto the range as soon as the vegetation began to grow, has been a major step in decreasing range depletion. Investigations showed that early spring is a critical period in plant growth, that higher yields are obtained for the season as a whole and there is less damage to the vegetation if grazing is delayed until plant growth is well started in the spring (*116*). Of significance in mountainous range also is

the fact that plant growth is delayed from 10 to 14 days with approximately each 1,000 feet of rise in elevation. In the various range units and elevational zones seasonal use has been adjusted according to the average dates on which the forage plants are ready for grazing as determined by records of plant growth built up over a period of years for many ranges.

Degree of utilization at the close of the grazing season also has been found to be an important criterion in range management on most national-forest ranges. The precipitation is poorly distributed through the grazing season, many of the better grasses and weeds are of the "bunch" growth habit and do not spread vegetatively; the soil usually is not resistant to heavy trampling and consequently forage growth does not withstand close grazing. Further research is needed to ascertain the degree of utilization which may be applied with impunity to important individual range species. Pending further findings the safety rule is used of aiming to leave unutilized at the end of the grazing season in average or normal years, from 20 to 30 percent of the forage volume of the more important forage species well distributed over the range.

Of the 4,281 cattle and horse allotments and 4,872 sheep allotments on the national forests, 88 percent are now considered to have satisfactory seasonal use. On many of the remaining ranges needed seasonal-use adjustments have not been made because of the lack of sufficient spring or fall range either inside or outside the national forests. In these cases it has been necessary to practice lighter stocking, or completely rest the range after the spring grazing season.

RANGE AND CLASS OF LIVESTOCK

In order to avoid waste of feed or damage, cattle and sheep whenever practicable have been changed about so that individual ranges are utilized by the class of livestock to which the range is best adapted. Character of topography, plant species, the presence of poisonous plants obnoxious to one kind of stock but not to another, and distribution of watering places are guides that have been studied on national forests to determine the proper class of stock to graze. However, the character of the supplemental winter range or forage supply, the nature of individual livestock enterprises, or other important factors sometimes outweigh the desirability of suiting the class of stock to the range. Range protection in these cases has involved lighter stocking or shorter grazing seasons.

GRAZING SYSTEMS

Systems of grazing have been developed to insure natural reseeding to maintain and improve the forage stand. Range plants which reproduce chiefly from seed require opportunity, at least in occasional years, to mature and disseminate a seed crop if the stand is to be maintained. Artificial reseeding has been found, because of expense and lack of species suitable to range conditions, to be less satisfactory than natural revegetation, except in extreme cases.

The deferred and rotation system (*114*) developed by the Forest Service is well adapted to meet natural reseeding requirements on ranges used throughout the growing season. Under this system a

given range unit is divided into from three to five subunits of approximately equal grazing capacity. Grazing is deferred on one of the subunits until after the seed of the more important range plants is matured and disseminated, after which the subunit is grazed to utilize the forage and aid, through trampling, to bring the seed into contact with the soil. The next year a second area is deferred and grazing on the first is delayed as late as possible to afford opportunity for the young seedlings to become established. Each subunit is deferred in rotation in subsequent years. This system operates very successfully on sheep ranges; on cattle range fencing or natural barriers to subdivide the range into subunits are necessary. It also fits in well with livestock-production practices where lambs or cattle are marketed direct from the range in the fall, because it affords fresh range for grazing prior to marketing.

Another system introduced by the Forest Service is conservative grazing throughout the grazing season to the point where in average years, at least 25 percent of the important plants well distributed over the range will attain seed maturity. It necessitates maintaining even distribution of livestock. It is simpler to apply than the deferred and rotation method, although it involves somewhat lighter use prior to seed maturity. This system is especially well adapted for use on ranges having a relatively long grazing season.

HANDLING LIVESTOCK ON THE RANGE

Prior to the establishment of administration on national-forest ranges cattle and horses were turned loose to roam at will. Sheep were herded, but bands were moved here and there, with little reference to the welfare of other herds or the range itself. About the only restrictions were "dead lines" separating cattle range from sheep range established in a few places as the result of the early range wars. Only where water was limited and the range was controlled through ownership of the watering places was there any semblance of order.

One of the first steps on the national forests to bring order out of this chaos and to eliminate the resulting damage to the range was to designate the area upon which each owner was to graze his livestock. Sheep ranges have been divided into individual allotments, each of a size and grazing capacity to accommodate one band of sheep for the prescribed grazing season. Ranges for cattle have been divided, usually into natural topographic units, and the cattle of specified owners are assigned to particular units. Stock driveways were designated over which owners might move their livestock to and from their allotted ranges without hindrance to other range users. Thus order was established out of confusion and the users were encouraged to take an interest in the condition of their ranges and to plan their enterprises on a more secure basis. The adoption of the range-allotment system and the elimination of the waste and destruction of range forage which resulted from the needless trailing and trampling incident to the jungle competition for the choicer pieces of range was a major accomplishment in range preservation on the national forests.

Both distribution and more even use of the range have been obtained in other ways. On sheep ranges the wasteful system of trailing into central bed grounds has been terminated. Sheep owners

were encouraged, and on many national forests required, to bed their sheep where night overtook them and have the herder camp with the sheep instead of bringing the sheep to camp. Bedding in one place more than 3 nights in succession has been prohibited. Sheep owners were encouraged to practice "open herding"—allowing the sheep to spread out in quiet open formation and to restrict the use of dogs. Grazing quietly into water instead of trailing long distances and not shading up along streams was encouraged to the fullest extent. Sheepmen soon saw the value of open herding and bedding-out systems, because, in addition to conserving the range, it resulted in 5 to 7 pounds greater gains in lambs.

Desirable distribution has proved to be more difficult with cattle than with sheep, especially on rough or mountainous land. The tendency is for cattle to overutilize the flatter places and underutilize the steeper slopes. Even on rolling or flat range, cattle congregate around watering places and damage the forage, particularly if the range is not well watered. Systematically locating salt grounds and salting at the right time and in the proper quantities has done much to bring about better distribution of cattle (*32*).

Herding and range riding, often required of the owners of cattle using the range, is another effective method applied to obtain better distribution. Riders and herders usually pay their own way by preventing straying and other losses.

RANGE IMPROVEMENTS AND CULTURAL PRACTICES

Various improvements which have been constructed on the national forests also have done much to improve range use, check depletion, and help restore the range. Drift and division fences have been used effectively in controlling and distributing cattle. Additional water developments have been instituted to help improve distribution on poorly watered range as well as to reduce congestion and trampling around drinking places. Trails and bridges have been built to open up otherwise inaccessible range. By the reduction of poisonous plants areas have been made safer which formerly were lightly used because of danger of poisoning livestock.

Rodents have been controlled on nearly 13 million acres on the national forests under direction of the Bureau of Biological Survey—an achievement that has not only reduced range depletion but has made available much additional forage for livestock. The Biological Survey also has materially aided the livestock industry and helped increase the game supply on national forests by its constant efforts to control predatory animals.

Many tests to reseed fully depleted ranges artificially have been made by the Forest Service (*52*) and some reseeding has been done. This method of range restoration is considered practicable if properly done. The best sites have responded satisfactorily to the species thus far found to be suitable. Areas for seeding must be selected with care. Ranges requiring reseeding are frequently those which have lost the better top soil by accelerated erosion. Many such sites are naturally too poor to respond readily.

INTERMINGLED STATE AND PRIVATE LANDS

The administration of grazing on the national forests is complicated by the occurrence of an aggregate of 10,500,000 acres of private or State-owned range intermingled in various-sized tracts with the Federal grazing lands. Most of this land was acquired either before the national forests were established or later under the forest homestead law. When such tracts are unfenced and are grazed without correlation with national-forest land, it is difficult to prevent trespass. A satisfactory procedure has been worked out whereby the owner of such lands waives exclusive use of his private land to the Government in exchange for a permit to graze free the number of livestock equivalent to the grazing capacity of the private lands, on some more convenient part of the national forest. In 1934, 3,677,000 acres of alienated land were handled under this plan. Where the owner does not graze livestock of his own, he may enter into a cooperative agreement with the Federal Government to receive a share of the receipts from other permitted livestock. This procedure results both in simplified management of national-forest range and in the privately owned land receiving the benefit of regulated use.

RANGE-MANAGEMENT PLANS

Out of the necessity for maintaining consistent action from year to year, and because of the multiplicity of elements involved in the management of the range resources, the Forest Service has worked out a system of specific range-management planning. General plans are prepared for a national-forest and ranger district, but the individual allotment or other range unit is the basic planning unit. The more important features in the development of a management plan are an appraisal or inventory of the resources, an analysis of the problems, the setting up of objectives, and defining the plan of action to reach the objectives. As much as possible of the pertinent data are shown on maps, including grazing capacity, period of use, movements of the stock on the range, location of salt grounds, present and needed range improvements, and deferred and rotation grazing systems. The plans for individual allotments, insofar as practicable, are worked out in cooperation with the user. The current program and usually a management map are furnished each permittee or cattle association. The plans are revised from time to time as experience and observation prove this to be necessary.

A systematic method of making surveys to obtain an inventory of the range resources and other basic data for determining grazing capacity and preparing range-management plans has been developed and applied. Up to the year 1934, approximately 50 million acres or 61 percent of the total usable range had been covered by such range surveys. Acceptable management plans have been completed for 82 percent of the individual range units in the national forests, including both those based upon range surveys and those on less comprehensive information. The remaining 18 percent have unsatisfactory plans or plans in various stages of completion.

The demand for range use is so great on most national-forest ranges as to warrant making fullest safe use of the forage. Under these circumstances regular periodic inspections are necessary in

order to discuss problems with the users, see that plans are being complied with, check on trespass, and observe conditions of the range. At least two intensive inspections a year by a qualified forest officer have been found to be the minimum requirement on intensively used ranges.

OBSTACLES AND PROBLEMS IN RANGE MANAGEMENT

Numerous difficulties and obstacles have retarded a more prompt and fuller attainment of objectives and have left many problems still to be solved in range management on the national forests. Some of these would naturally arise in any attempt to establish a new order in land utilization. Others are due to economic, social, and political forces of the times. Still others are inherent in the ranges themselves.

SOCIAL, POLITICAL, AND ECONOMIC INFLUENCES

One of the more deep-seated obstacles to greater progress in range restoration on the national forests has been the delay in practical acceptance of principles of conservation by the stockmen, in spite of the fact that it was in their interest in the long run to do so. There is broad agreement as to the validity of the general theory of husbanding the resources of the land but its application has not been readily incorporated into actual practice. One has only to know the situation on most of the privately owned range lands in the West to be convinced of this fact.

That this obstacle has been encountered perhaps is not surprising. The national-forest enterprise constitutes the initial attempt in the United States to apply conservation principles on a large scale in the use of public land. It represents the very antithesis of the exploitation which, until a positive administration was undertaken on the national forests, had pervaded so much of land use in this country. It is a reversal of the old economic order of extracting everything possible from the soil for immediate profit without regard for its effect on sustained yield or future needs. More or less resistance to such a change naturally was to be expected.

Not all of the restrictions necessary to protect and maintain the range on the national forests have been opposed by the stockmen; some have been readily agreed to and others passively accepted. In too many other instances, however, there has been active opposition—sometimes from purely selfish motives—and strong political pressure has been brought to bear, all of which has greatly delayed though seldom defeated adjustments needed to conserve the range.

Economic conditions, also, have interfered with adjustments in range use. National-forest range users often have been the victims of circumstances which have forced them to think largely in terms of immediate needs and to request delays in reductions of numbers of stock or changes in practices to protect the range. The inadequate credit facilities, high interest rates, poor markets, maladjustments in land use, high cost of feed, inadequate supplemental range, aggression by stronger competitors in the use of the open public domain, and speculative land values that livestock producers have had to face, have somewhat hampered the application of national-

forest management practices. Often it has been in the interest of immediate individual and community welfare for the Forest Service to retard adjustments in range use until economic conditions were more favorable for the stockmen to meet their business obligations. During the past 5 years of economic difficulty, for example, one means of extending relief has been to delay making necessary reductions in grazing use even though these were needed to repair damage by drought and to avert further impairment of the range.

CHANGING DEMANDS

New requirements incident to the growth and development of the West have created new demands for the public use of national-forest resources. The increased demand for game and recreational use and a fuller appreciation of the requirements for watershed protection are examples. The immediate needs of range users must be considered in meeting the requirements of these broader public interests. Adjustments seldom can be made abruptly without subjecting those directly dependent on the land for a livelihood to hardships. Sometimes overzealous demands, based upon misunderstanding, as, for example, the opposition to the reduction of game animals on ranges overgrazed by game, result in sharp clashes between conflicting interests and in delayed action. Usually it is in the greater public interest to work these problems out slowly even though to do so involves some delay in range restoration.

THE WORLD WAR

The effect on the range of the United States' entrance into the World War in 1917 has already been mentioned. With the whole Nation turning its efforts toward increasing the production of materials and supplies needed for national defense, restrictions against overstocking the national-forest ranges were necessarily slackened. This was done as a part of the program to increase supplies of meat and wool, even though it was realized that to do so would lead temporarily to delayed range improvement and possibly to impairment. Some of the ranges were overstocked when the United States entered the war. The total increase on the national forests during 1917 and 1918 amounted to 188,000 cattle and 876,000 sheep, or approximately a 10-percent increase on ranges already fully or overstocked. In view of the fact that producers had been encouraged to enlarge their operations and could not liquidate on short notice after the close of the war without undue sacrifice, these excess livestock were not removed at once. The adverse economic conditions which followed shortly after the close of the war further delayed and complicated the necessary adjustments. It was not until 1923, fully 5 years after the war, that these excess livestock were all removed. In the meantime considerable damage to the range has resulted from overgrazing which called for further reductions.

DROUGHT

The variable climate has been another handicap to progress, as indicated in a previous section. Rainfall especially has varied

widely from year to year and between groups of years. The aim has been to stock the ranges conservatively enough to avoid injury from droughts of short duration. Long-term droughts have been more difficult to meet. Rainfall has been below average over most western ranges since about 1917 or 1918, and there have been years of severe drought within this period. In the very serious drought of 1928 to 1934 the absence of available feed made it impractical to remove livestock from the national-forest range, and in some cases necessitated increased use as a measure of drought relief. The deficiency in forage production without a commensurate reduction in the numbers of livestock eventuated in serious overgrazing which, together with the weakened condition of the range vegetation attributable directly to drought, culminated in serious widespread depletion of the range. To this set of circumstances is chargeable the major part of the reductions in numbers of livestock needed for range protection on the national forests at the present time.

THE CHARACTER OF THE RANGE

The physical character of the national forests themselves make it extremely difficult to apply management which will result in uniform improvement of the range. The wide variation in elevation from foothills to high mountain tops, the broken topography, differences in soils, slopes, and exposures, and the resulting differences in climate and growing conditions, give rise to a variety of conditions as to plant cover and usability of the range often within a horizontal distance of only a few miles. The vegetation on the whole is naturally not resistant to close use or heavy trampling. The balance between plant cover and stability of the soils is delicate and the steep slopes, thin cover, loose soils, and torrential rainfall induce erosion immediately when the plant cover is broken. Because of all these conditions local overgrazed areas or "sore spots" have persisted.

Soil depletion, as the result of overuse and consequent erosion existent on extensive areas when grazing administration was undertaken, has been a serious handicap to range restoration. Rehabilitation of these soils necessarily is a slow process and insufficient time has elapsed to result in much improvement. On some ranges in Utah, for example, there has been but slight recovery on severely eroded soils on which grazing has been excluded for the past 20 years.

MALADJUSTMENTS IN RANGE USE AND OWNERSHIP

When first placed under regulation much of the national-forest range was being grazed for longer seasons than proper management would allow. Solution of this problem has been slow and difficult because of the shortage of available spring and fall range on outside land. Certain of the outside range lands which might best be used for this purpose in connection with national-forest range—including parts of the open public domain—were being used at other seasons. Much of the available spring and fall range was badly depleted. The area originally suitable for this purpose has been greatly reduced by cultivation. As yet the seasonal-use problem has not been satisfactorily solved on 12 percent of the national-forest range allotments,

nor will be until some major readjustments are made in use of the outside land.

Other maladjustments in ownership or control of land which complicate range management exist within and along national-forest boundaries. Approximately 12 percent of the grazing land within national forests, or about 10,500,000 acres, is alienated and of this only 3,677,000 acres is being handled as an integrated part of national-forest range units. Efforts to exclude all but timber and important watershed land when the national forests were established as well as subsequent eliminations have resulted in many natural range units being left partly inside and partly outside the national-forest boundaries. This has prevented proper management and coordination of use of land both inside and outside the forests.

DELAYS IN THE DEVELOPMENT OF RANGE MANAGEMENT

Still another handicap to higher attainment on national-forest ranges, already mentioned, was the lack at the outset of an experienced and trained personnel and the paucity of knowledge of range management. Range management was a new field in which the ground had scarcely been broken. It was only as the personnel became better trained and more experienced and as new facts and principles were developed by research that standards and practices of the "rule-of-thumb" era were discarded and scientific range management began to take shape.

Lack of sufficient funds to carry out various undertakings as soon as they were recognized to be needed in the application of better range management has been another cause for delay. Earlier installations of fences and watering places would have helped to speed up range rehabilitation. The range-research program has been slow in getting under way. A larger technically trained range-management personnel is needed. Numerous problems, many of urgent importance, remain to be solved. There are 56,800,000 acres of national-forest range land still to be covered by resource surveys to supply data for the preparation of adequate management plans.

RANGE-DISTRIBUTION POLICY

Most of the ranges were already fully occupied when the national forests were established, chiefly by large livestock owners who were operating on an industrial basis, but also by homesteaders and other settlers who had come in and were beginning to gain a foothold on the range. The country was still in the developmental stage. The West was looked upon as the land of opportunity for the home seeker. The general conception of the times was that all an individual needed was the opportunity to obtain a piece of land and a few head of livestock and with the free play of economic forces he would eventually build up an economic home unit; the national-forest regulations were framed to foster this kind of development.

In carrying out this objective with regard to the use of the range, the following policies have been applied in the allocation of grazing privileges: (1) Preference is given to the small settler or home builder to afford him an opportunity to build up his agricultural enterprise into a unit capable of satisfactorily supporting a home:

(2) in order to obtain the highest use of both public range and farm land, preference is given to owners of farm land or winter range who require summer range for the number of livestock they can support during the remainder of the year with the products of their cropland or on owned range land, or both; (3) no rights have been allowed to accrue to permittees, but in order to promote stability in livestock agriculture, individuals best qualified under the regulations have been safeguarded in their use of the range to the fullest extent consistent with objects of the national forests and the needs of other qualified range users.

Permits to graze were issued at first to all stockmen who had been making bona-fide use of the range for a number of years prior to the time it was set aside as national forest.

Rules and regulations designed to encourage redistribution to small owners without forcing sudden sacrifices on bona-fide, previously established users were then applied and subsequently have been followed in the issuance of the year-to-year or occasional term permits.

Ownership rather than leasing of land is given prior consideration because leasing lacks permanency and involves the elements of speculation. Residence on the ranch property is given preference over nonresidence.

In order to interfere as little as possible with legitimate business transactions, the permit of an established permittee is renewable to the purchaser of the dependent and otherwise qualified ranch property of an established permittee, or of permitted livestock, if the purchaser already owns properly qualified ranch property. Since a grazing preference is a privilege and not a right, it must be waived by the seller of the ranch or livestock to the Government which in turn renews it to the new purchaser. In the case of the death of an established range user the permits may be renewed to the heirs. Whenever the range is overstocked or there is a demand by other better qualified users, the size of the permit to the purchaser or heir may be reduced prior to renewal.

In order to prevent monopoly of the range by the purchase of ranch lands or livestock entitled to a grazing preference, and the exclusion thereby of other qualified users, a maximum number any individual may graze has been established for each national forest, beyond which a permit number may not be increased, except under extraordinary circumstances.

Minimum limits also have been established below which no permit number is reduced, to make room for new users or to increase small permits. Such reductions are made on the larger sized permits. This minimum limit is, in each case, an approximation of the minimum number of livestock which, in connection with the owned farm and range land, will help to produce a reasonable standard of living for a family, and varies depending upon local circumstances and conditions. It is lower where it relates to diversified agricultural enterprises in which the grazing of a few livestock is essential to supplement farm-crop production. It is higher where it applies to enterprises where livestock raising in connection with forage-crop production or owned winter range is the chief source of income.

OUTCOME OF DISTRIBUTION POLICY

The system of allocating the use of the range on the national forests on the whole has contributed materially to the stability and maintenance of western livestock agriculture. The practice of relating the use of the public range to the other agricultural resources has resulted in making both types of land contribute a higher economic return than if each had been used independently. The administration of the national forests has been the largest accomplishment in planned land used in the West. The forage supply on national-forest range has been the most dependable of all of the factors entering into the economy of livestock producing enterprises. The advantage which the bigger, more aggressive operator might have exercised on the range by virtue of stronger financial position and greater resourcefulness has been removed.

However, the expectation that there would be a material building up in the number of individuals benefited and in the number of livestock they each grazed has not been fulfilled. Instead of a wider distribution of grazing privileges among a larger number of individuals, the situation, especially with cattle, is much the same as in 1909.

There were 27,237 permittees in 1909 and 26,224 in 1934. The relative number of cattle permittees in each of four permit-size classes, as shown in table 50 (columns 2, 5, 8, and 11) has remained approximately the same over the 25-year period, as has also the relative proportion of the number of cattle in each class (columns 3, 6, 9, and 12) and the average size of the permits (columns 4, 7, 10, and 13). The only notable exception has been a decrease in the average size of permit in class IV, the largest size class, from 501 head in 1909 to 425 head in 1934. The smallest size class of permittees, who make up 62 percent of the total number, own only 15 percent of the total number of cattle grazed. On the other hand, the 7 percent of cattle permittees in the largest size class own 44 percent of the total number grazed.

The situation with sheep is somewhat different. Sheep permittees number only about one-fourth as many as cattle permittees, although they own approximately one-half the combined livestock units (sheep being counted at a 5 to 1 ratio with cattle). The relative number of permittees in the small-size class (column 2 in table 50) has increased appreciably as has also the relative number of sheep in this class (column 3); however, a part of this increase, as well as a part of the decrease in the number of class I cattle permittees is due to permittees having exchanged from cattle to sheep. There has also been a decline at the opposite end of the scale, in

TABLE 50.—*Distribution of grazing permits on the national forests, according to size classes, 1909–34*

CATTLE[1]

Year	Class I (1–40 head)			Class II (41–100 head)			Class III (101–200 head)			Class IV (over 200 head)			Average size of permits of all grades
	Number of permittees	Number grazed	Average size of permit	Number of permittees	Number grazed	Average size of permit	Number of permittees	Number grazed	Average size of permit	Number of permittees	Number grazed	Average size of permit	
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
1909	*Percent* 64	*Percent* 15	*Number* 16	*Percent* 20	*Percent* 19	*Number* 66	*Percent* 9	*Percent* 18	*Number* 149	*Percent* 7	*Percent* 48	*Number* 501	*Number* 72
1914	60	12	16	19	18	67	8	18	145	7	49	484	68
1919	63	13	17	20	20	67	8	17	146	7	47	497	69
1924	64	13	17	20	20	67	9	18	144	7	47	470	69
1929	64	15	16	20	18	66	9	20	146	7	47	445	70
1934	62	13	17	21	20	66	10	21	146	7	44	426	69

SHEEP[2]

Year	Class I (1–1,000 head)			Class II (1,001–2,500 head)			Class III (2,501–4,000 head)			Class IV (over 4,000 head)			Average size of permits of all grades
	Number of permittees	Number grazed	Average size of permit	Number of permittees	Number grazed	Average size of permit	Number of permittees	Number grazed	Average size of permit	Number of permittees	Number grazed	Average size of permit	
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
1909	*Percent* 48	*Percent* 13	*Number* 423	*Percent* 35	*Percent* 30	*Number* 1,896	*Percent* 8	*Percent* 17	*Number* 3,160	*Percent* 9	*Percent* 31	*Number* 7,286	*Number* 1,541
1914	47	13	416	39	42	1,850	8	16	3,102	6	29	7,005	1,469
1919	57	18	381	32	41	1,929	6	15	3,204	5	26	6,667	1,307
1924	61	19	366	29	38	1,834	6	18	3,222	4	27	6,733	1,189
1929	64	22	350	27	40	1,908	5	15	3,120	4	23	6,600	1,042
1934	62	21	366	30	42	1,926	5	14	3,178	4	23	6,647	1,071

[1] Includes a relatively small number of horses and a few swine, not segregated for the purposes of this discussion.
[2] Includes a relatively small number of goats, not segregated from sheep for the purposes of this discussion.

relative number of permittees (column 11), in relative total number of sheep grazed (column 12), and in average size of permit (column 13). These decreases have been reflected in a decline of about 30 percent in the average size of sheep permit (column 14). The data on sheep permits, therefore, indicate that there has been noticeable redistribution among the various size classes.

Size of permit, however, is not the only criterion of sufficiency of numbers of livestock to meet the needs of individual permittees. The size classes, especially for cattle and to some extent for sheep, shown in table 50 relate to many kinds of livestock-agriculture enterprises, varying from small diversified farms with a few head of cattle or dairy farms which require summer range for a few head of young animals, to practically exclusive livestock-producing ranches, with all sorts of combinations in between. A few to 40 head of cattle or up to a few hundred sheep, for example, form a very valuable and usually sufficient adjunct to other farm production on a diversified farm, both as a source of fertilizer for field soils and of cash income. On the other hand, this small number is seldom sufficient to round out a satisfactory home-supporting unit when livestock are the chief source of income. Since the permits relating to the various kinds of livestock-agriculture enterprises are not segregated in the available data presented in table 50, size of permit alone does not show the full significance of the range-use distribution policy of the Forest Service.

In order better to understand the influence that economic forces may have had on size of permits on national forests, a comparison should be made with otherwise similar livestock-agriculture enterprises which do not participate in the use of national-forest range; but data to make such comparison are not available. A possible hint along this line, however, is contained in the census data showing that the average number of cattle and sheep per farm in the 11 Western States has decreased in approximately the same degree as the average size of permits on the national forests. The average size of cattle permit declined from 72 head in 1909 to 69 head in 1934, and the average number of cattle per farm from 24 head in 1910 to 20 head in 1930. Similarly, sheep per farm declined from 74 head in 1910 to 50 head in 1930, or about 32 percent as compared to a decline of about 30 percent in average size of sheep permits on the national forests. It would appear from these data that the trend has been approximately the same among owners who do or do not use the national-forest ranges.

Many factors other than the policy of administration as expressed in the Forest Service regulations have had an influence in the redistribution of grazing privileges on the national forests, and in many instances these may have dominated. Adequate data are not available for a thorough analysis but, as shown in the following paragraphs, certain conclusions may be based on the information at hand.

During the period 1909 to 1934, a fairly large number of permits was granted to owners in the smallest size class who had not previously used the national-forest range. Substantial reductions were made also in the larger-sized permits to provide range for the beginners and to increase the size of many of the smaller permits. In a few places permits in the two intermediate size classes have been granted to new applicants but only where unused range was not wanted by small operators. Practically all of the reductions in size of permit for the benefit of range protection have been made in the larger-sized classes. Only in rare instances, where there were not enough large permits to absorb the reductions needed for range protection, have cuts been made in the smaller-sized permits.

In spite of this deliberate action by the Forest Service and a negligible number of cancelations of grazing permits for the persistent violation of the national-forest regulations or for other cause, there has been a slight decline in the relative number of small cattle permittees. Furthermore there has been no sustained increase in the average size of permits held by them.

Many of the small permit holders have sold their ranch property or permitted livestock or both to other stockmen to whom the permit has been renewed and in this manner two or more preferences in numerous instances have been combined. In some cases small operators have built up their permits into the next size class. In other cases larger operators whose permits have been reduced either for redistribution to other users or for range protection, subsequently purchased additional livestock or ranch property of some smaller permittees, and in that way many of the larger permits have been more nearly maintained than otherwise would have been the case. For still other cases, the permits, usually in the small size classes, have been voluntarily abandoned.

A study made in several of the Western States in 1935 indicates the extent to which preferences have been passed from one permit holder to another or abandoned during the period 1905 to 1934. In Wyoming, Idaho, Nevada, and eastern Oregon, as shown in table 51, there has been a relatively heavier dropping out of small permittees and the larger permits on the whole have been the most stable. On the other hand, in Utah the small permits have been more stable and more of them are still in the hands of the original holders than in any of the other States. In Utah, relatively more of the permit holders are engaged in diversified farming or outside labor and depend less upon livestock for their income than in the other four States. A study in eastern Oregon shows further that about 75 percent of the permittees who have dropped out did so within 5 years after obtaining a permit. These data suggest that where livestock production is the chief source of income, the small-sized permits are not economically sufficient and after a few years of use the livestock are sold and the permit is transferred to a new holder, either another new small owner, an already established small permit holder who is endeavoring to build up to an economic unit, or an established large-sized permit holder who desires further to build up his permit.

The data in table 51 also indicate a considerable lack of stability in ownership of livestock in all permit-size classes. During the past 30 years there has been an average of almost two predecessors for every present permit holder or an average length of life of a permit of between 10 and 15 years. This succession in ownership is ascribed to the unsettled condition in agriculture in the Western States. The lowest turn-over on the average has been in Utah where there is more extensive diversified farming in the vicinity of the national forests and a more settled type of agriculture than in the other States. No data are available to afford a comparison in stability of livestock ownership by ranches using outside range with those using national-forest range.

TABLE 51.—*Percent of original permittees who have dropped out on national forests in 5 Western States, 1905–24*

Size class	Utah	Wyoming	Idaho	Nevada	Eastern Oregon
CATTLE					
I (1 to 40 head)	Percent	Percent	Percent	Percent	Percent
II (41 to 100 head)	51	74	72	87	57
III (101 to 300 head)	54	63	65	101	78
IV (over 300 head)	63	54	69	83	79
	69	37	45	81	73
SHEEP					
I (1 to 1,000 head)	43	37	52	73	58
II (1,001 to 2,800 head)	30	33	73	85	79
III (2,801 to 4,000 head)	60	0	76	67	77
IV (over 4,000 head)	75	13	87	85	87

These admittedly incomplete data substantiate a conclusion based on wide observation, that economic forces beyond the influence of the national forests have played a large part in controlling the distribution of grazing privileges. Small-sized permits, except where associated with diversified farming or other source of income, because of being undersized or submarginal in character, have proven insufficient in many instances to constitute a base upon which the small settler might build a satisfactory home unit and have been abandoned or transferred from one holder to another. More often the transfers are to a larger permit holder because the small permit holder who might like to enlarge is unable to buy the necessary land upon which to care for his livestock for the portion of the year they are not on the national-forest range.

Other factors have had some influence also. One of these is the term permit. When these are in effect there is less opportunity to make reductions on the larger permits for the benefit of smaller holders.

A second factor has been the need for making reductions in number of livestock grazed for the purpose of range protection. Almost all of these reductions have fallen on the large operators, and when these cuts have been heavy there has been a reluctance on the part of the Forest Service to make additional reductions for the purpose of admitting new permittees or granting increases to small permit holders.

In some degree also the Forest Service perhaps has not been aggressive enough in carrying out the policy of redistribution in favor of the small settler. There are a number of rather large permits still in existence, although all of them have been greatly reduced at one time or another. Some of these at least, after having been reduced, have been built up again through purchase by the holder of ranch property or livestock of another permittee. On the other hand, the small number of livestock granted to many of the small permittees undoubtedly has been insufficient to constitute economic-sized operating units, and the permits have been given up or the livestock sold to someone else. The heavier turn-over in small permit holders in many States strongly suggests this possibility. The alternative would be granting an economic-sized permit to begin with. At any rate, it is apparent that merely granting a small permit will not suffice as the sole basis for building up an economic unit, and the fact remains that there is still a large number of small farmers in and adjacent to the national forests, many of whom have no permit at all and others who have only a small permit, insufficient satisfactorily to support a home.

The national-forest range, however, is insufficient to afford anywhere near an adequate size of permit to all of these settlers, even if the larger-sized permits were eliminated entirely. Further redistribution of grazing use on public land is desirable in many localities, some of which can be done without more fundamental adjustments, but the lack of sufficient range to meet all needs suggests the necessity of finding other means than further distribution in the use of national-forest range alone to solve the problem. It would be unwise to attempt redistribution on a big scale without a sounder basis than the present available information can afford. At most, it is a national-forest problem only in part. All ownerships of land, including farm land, privately owned, and State range land, the grazing districts, and the remaining open public land, should be considered together in order to adjust and harmonize ownership and use among all classes of land. There are two courses to follow, either the doctrine of laissez faire, in which the fittest will finally survive, which, except for the preference given the smaller permittees on national-forest range, has been the policy of the past, or the planned way of ascertaining the facts relating to all classes of land and then determine the course which will result in the greatest benefit to the greatest number of people. This constitutes one of the major unsolved problems in national-forest and other types of land use.

NET RESULTS OF 30 YEARS OF RANGE ADMINISTRATION

The national forests represent the pioneering effort to apply conservation and planned land management on a large scale in the United States. During 30 years of intensive administration, range management on these areas has been confronted by the many obstacles and difficulties detailed in the preceding pages, all of which have in some measure hindered and delayed necessary action and retarded the accomplishment desired. During this period, however, definite aims and objectives in line with maintaining and improving the natural resource have been held to, whereas on private and most

other public ranges exploitation of the resource has continued with little effort to control it.

The net results of these 30 years of effort may be summarized as follows:

1. The trend of depletion of the range has been checked, and notable improvement is the rule. The grazing capacity of the range area in use in 1934 has been improved 19 percent since 1910. Grazing capacity on national-forest ranges today is, on the whole, 70 percent of that on virgin range, as compared to 33 percent on the grazing districts and the public domain and 49 percent on privately owned lands in the Western States. At the present time, even in spite of a long period of deficient rainfall, the 1928-34 drought, and the extra demands of the 1929-35 depression, only 19 percent of the range area on national forests is in such condition as to require major adjustments in use to permit continued improvement.

2. The watershed lands, which include the heads of practically all of the important streams furnishing water for irrigation, hydroelectric power, and domestic use in the West, have been protected from serious damage and are mostly in an improved condition. Many mountain streams subject to destructive floods and mud flows from torrential summer rains when the national forests were established seldom have such floods today. Disastrous floods on national-forest watersheds are rare occurrences except from recent burns or those few areas on which an adequate cover has not been restored. This is in sharp contrast to much similar privately owned or other Federal lands, excepting the ungrazed national parks and municipal watersheds. Erosion of topsoil and gullying have in a large measure been checked on national forests, although they are still too prevalent. They are extremely small in relation to the extent of erosion on other lands. Along with the benefit of watershed protection, streams in the national forests have been maintained in condition to support trout and other game fish.

3. The policy of "multiple use" developed on national-forest land has made available all of the resources in a manner to obtain the highest net use of all the land. Of the 87,954,000 acres of usable grazing land only 5,416,000 acres have been closed for other more important uses. On the remaining 82,538,000 acres, watershed protection, timber production, grazing, production of wildlife, and recreational use are correlated and harmonized.

4. When the national forests were established, the population of wildlife in the Western States was at or near its lowest point in history. By giving wildlife a definite place in land management, by urging and assisting in the enactment of better State game laws, by cooperating with the several States in game-law enforcement, and in the establishment of more than 100 game refuges on the national forests, and by developing better game management, the number of game animals and possibilities for hunting have been greatly increased. The control of predatory animals under the direction of the Biological Survey has also helped greatly in raising the game population. Big-game animals on range lands in 1924, the first year complete estimates were made for all species, numbered approximately 612,000 head. In 1934 they were estimated to number 1,084,000, or an increase in that period of 77 percent. By developing roads into the national forests and by planting fish in

streams in cooperation with other Federal agencies and States, recreational sport has been made available to hundreds of thousands of fishermen. The additional hunting and fishing not only has added to recreational enjoyment by city and country people alike, but the goods and services required by sportsmen have added to the business of merchants, hotels, and guides in the communities adjacent to the national forests.

5. The giving of preference in the use of the forage resources on the national forests to nearby residents who need summer-range land to supplement and properly utilize their farm and winter-range land, and thereby to supplement and round out farm or ranch home units, has resulted in higher use of both the national forest and privately owned land. It represents one of the few large-scale efforts to put better land use into effect. Although successful insofar as it has gone, accomplishments have been limited by maladjustments in land use and ownership, economic conditions, and other factors outside the national forests.

6. The aim of protecting the small operator and affording him the opportunity to build up an economic home unit has been accomplished only in part. National-forest administration helped to put an end to range wars, eliminated the nomad operator on the summer range, and protected the little man against monopoly of the range by his stronger, more aggressive neighbor. Small operators have been afforded more than equal opportunity with large operators to use the range. The various other elements in range livestock production, including credits, markets, cost of feed, and land values, have been far less stable or dependable than the availability and cost of national-forest range forage. However, the expectation that many of the smaller operators would build up into units capable of satisfactorily maintaining a family has not been realized. Large operators are fewer in number and have been reduced in size in order both to stop overgrazing the range and to make more range available to small operators. Nevertheless, the relative number of small operators and the average number of cattle grazed by them have not been increased, although there has been an increase in the number of small sheep owners. The lack of increases in the case of cattle is believed to be due in a large degree to maladjustments in land use and ownership outside the national forests and in some degree, probably, to a too conservative application of the redistribution policy.

7. The final objective in the protection, development, and use of the national-forest resources is the establishment and maintenance of a stable population. The net results of the dependability of the range-forage crop, the greater opportunity for small operators, correlation of national-forest range with dependent farm and ranch land, and multiple use of the related resources has contributed materially to stabilizing home and community development. The settlements around the national forests have a dependable supply of wood, water, forage, game, and recreational advantages. These lands are great reservoirs of useful work in time of economic stress. The counties in which national-forest ranges lie receive 25 percent of the receipts collected for grazing and other uses for their roads and schools. The development and protection of the national-forest properties and other work done by the Federal Government is a source of income to local labor, has relieved the several States of

heavy expenditures, and has prevented the waste of resources basic to the welfare of these States.

8. In its endeavor to solve its own range land and watershed problems the Forest Service has developed a science and practice of range management and watershed protection which is applicable to other classes of range land as well. It has pioneered the way in the soil-erosion problem on forest and range lands and was the first to undertake comprehensive study of it. It has been among the first to study and obtain concrete information on the range problem on the open public domain and has constantly urged action to correct it.

9. The average annual cost of administration of grazing on the national forests for the 4 years ended June 30, 1935, was 0.89 cents per acre of usable range. This cost, however, does not include the cost of range improvements constructed with emergency and relief funds and personnel during 1932 to 1935. Present personnel and facilities for administration, however, are inadequate to render the services required and should be enlarged. The income from grazing for this period amounts to 1.46 cents per acre. Whether or not this cost of administration is too high should be judged only on the basis of the needs of this job. The Forest Service has held to two broad aims or objectives—conservation and protection of the resources and provision of the maximum public benefits therefrom. Either or both may be sacrificed; but if so, it must be expected that cheaper administration will result either in damage to the resources or in reducing use to a point where the dependent population will be denied the resources which otherwise might be available to them, either of which lead to social and economic losses.

These accomplishments are attributable to the following:

1. The setting up of definite aims and objectives and adhering to them.
2. Anticipating problems and preparing to meet them.
3. A decentralized form of organization.
4. Professional resident management.
5. Accepting full responsibility for decisions, even when superficially contrary to immediate advantage of range users.
6. Equal consideration for all resources.
7. A long-term viewpoint which leaves the way open for meeting new needs as they arise in the use of the resources.
8. Jurisdiction over the national forests in the Department of Agriculture, where activities relating to growth from the soil are grouped.

Many problems remain to be solved. Further adjustments are needed to reduce use to the grazing capacity of the range. Seasonal changes are needed on 12 percent of the grazing allotments. Management plans including range inventories have not been completed for all the ranges. Additional improvements, artificial reseeding, and other work remain to be done. Adjustments must be made as needed to meet the requirements of multiple use. During 1932 to 1935 intensive range management has lagged, owing to so much time of resident forest officers being required on emergency relief work. Probably the biggest single unsolved problem in connection with the national-forest ranges is the development of a more adequate basis for distributing grazing privileges in accordance with sound social and economic policies. This involves correcting malad-

justments in land use on outside agricultural land as well as a resurvey of national-forest policies. Additional research is the foundation to the solution of many of the problems.

Indian Lands

Range lands within Indian reservations occupy a unique place in the consideration of the national-range situation. This is so, not on account of the considerable area or commercial importance, but because these lands belonging to the Indians constitute a definite responsibility of the Federal Government for management and administration.

The legal status of each Indian reservation or individual tract of Indian land now rests firmly on the provisions of an Indian treaty, and Executive order, or Federal patent, definitely recognizing or establishing indisputable Indian title to the property and in most instances restricting passage of this title. The Indians are wards of the Federal Government and this guardianship extends to the supervision and administration of the Indian lands.

The uses to which the Indian range has been devoted, the steps taken in its administration, the present ownership status, and even the extent and physical condition of the resources are intricately involved with the ever-changing degree of interest in Indian affairs; and are reflections of the efforts of the Federal Government to direct the use of the land resources of the Indian toward fostering his social and economic development. The multiplicity of aims and social theories involved has resulted in a rather complicated pattern of achievement.

In 1849 the Bureau of Indian Affairs was transferred from the War Department into civil control as a bureau of the Department of the Interior. Since then the functions of the Bureau of Indian Affairs have been developed to a high degree of beneficent paternalism. In addition to providing services as an aid to the health, education, employment, and other personal needs of the Indians, progressive steps have been taken in the management and development of the reservation properties, including activities directed toward the conservative management of the Indian range lands (*83*).

Indian Range Resources

Over 80 percent of the total land in Indian ownership is within the range livestock-producing regions of the West. Plant types and forage characteristics of these broad regions have been fully discussed in an earlier part of this report, and are not reviewed here except to mention that the forage on the various Indian reservations is basically the same as that which occurs generally throughout the territory of which they are a part. Several plant types suitable to the ranging of both sheep and cattle are found on each major reservation regardless of location. The distribution of Indian land valued for forage production by States and grazing types recognized by the Indian Service, as compiled from 1934 statistics, are presented in table 82. Of the 43,000,000 acres given a range-land classification, slightly over 3 million is listed as barren or waste, leaving a balance of over 40,000,000 acres for use by livestock.

On nearly all of the 47 reservations summarized in table 52, full use is made of the annual forage crop. In 1934 approximately 10 million acres were under temporary lease or permit to whites, pending the time the range is needed for Indian livestock. Indian livestock owners paid grazing fees on an additional 1.7 million acres and on the remainder, comprising nearly three-fourths of the total, Indian-owned livestock were grazed on a free use basis.

The relative proportions of white and Indian ownership and the total livestock reported using the range in 1934, are shown in table 53.

TABLE 52.—*Areas of Indian reservations of range importance by types and States*

State	All range land	Open land	Sage and brown type	Coniferous timberland	Woodland	Aspen	Waste and barren
	Acres	Acres	Acres	Acres	Acres	Acres	Acres
Arizona	21,518,000	2,620,991	4,000,284	2,200,641	2,708,118	3,740	1,987,221
California	273,685	21,888	133,040	68,650	49,113		184,033
Colorado	185,333	44,000	80,000	418,195	12,514		13,322
Idaho	880,884	10,000	270,236	44,100			
Montana	5,853,195	2,267,888	432,236	403,044	388,840	101,200	272,100
Nevada	1,200,207	113,973	205,770	2,215		7,000	101,000
New Mexico	5,041,000	1,406,707	615,949	782,000	433,275	1,000	305,740
North Dakota	244,000	224,516	20,000		20,054	1,000	27,140
Oregon	1,000,720	80,784	304,000	1,254,004	34,000		11,000
South Dakota	3,720,420	3,514,704		50,488	36,240		120,000
Utah	2,100,000	1,113,170	176,210	20,000	65,000	2,200	17,000
Washington	2,100,000	240,667	227,267	1,000,217			24,000
Wyoming	820,140	198,220	270,205	135,000	2,000	200	120,000
All States	1 45,263,000	30,400,118	5,143,410	6,608,700	4,775,329	117,220	3,147,000

1 The total area of range available to domestic livestock on Indian lands in the West, as shown elsewhere in this report, is 46,201,000 acres inclusive of small areas of waste range within the larger bodies of range land. The acreage shown in this table is exclusive of public domain Indian allotments, small fenced tracts within reservations, or other areas within Indian ownership which have not been classified as to forage type. In the few instances where a reservation extends into two States it is listed here and in following tables with the State in which the Indian agency is situated.

TABLE 53.—*Indian- and white-owned livestock on ranges, 1934*

Ownership	Cattle	Horses	Sheep	Goats
	Number	Number	Number	Number
Indian	229,543	134,963	501,762	215,000
White	257,460	20,943	971,000	
Total	486,903	155,906	1,472,762	215,000

The Indian-owned livestock make use of the reservation range for the yearlong period except when it is covered with snow. In some localities, particularly on the northern reservations, supplementary feeding is practiced; but by far the larger percentage of the Indian stock graze yearlong on the reservation ranges. The white-owned stock generally is grazed under permits specifying the season of use, which varies from a few months of intensive summer grazing to more moderate use over a longer period, depending on the nature and location of the range. The Indian ranges on the larger reservations are quite important sources of feed, and there is ready demand for use by white-owned livestock of the forage not needed for Indian livestock.

The present condition of the ranges varies widely in different regions. The Indian range lands in Oregon and Washington, except for some minor localized injury due to faulty distribution of stock, are in good condition. On the northern Great Plains reservations, where the native sod of buffalo grass has been undisturbed and the area used solely for grazing, the ranges are also generally in fair to good condition. Some futile attempts at dry farming have destroyed the native vegetation, but it is estimated that somewhat less than 100,000 acres of plowed Indian land in the Plains States should be returned to grass.

In the Southwest the situation is serious. Approximately one-half of the total range lands in the Navajo, Hopi, and Papago country, particularly, is seriously overstocked and presents a severely overgrazed condition. Erosion by both wind and water has removed and is still removing the fertile topsoil on hundreds of thousands of acres. The condition of these ranges, in spite of the first steps toward corrective measures which have been taken, is steadily growing worse. The fine texture of the soil and the absence of sod-forming vegetation, together with irregular torrential showers, cause a heavy run-off which results in serious damage (*20*). Drastic action toward livestock reduction and range rehabilitation will be necessary on millions of acres before the Indian range lands of this region are again capable of making their full contribution to the welfare of the Indian owners or the Nation as a whole (*161*).

A survey of western ranges made in 1935 indicates that the Indian lands on the whole have been depleted approximately 51 percent of virgin condition, and about 4 percent of the total usable range area is extremely depleted, 54 percent is severely depleted, 36 percent is materially depleted, and 6 percent of the range is only moderately depleted. It is believed that in virgin condition these Indian ranges had a grazing capacity at the rate of 4.2 acres for each animal-unit month. The present carrying capacity is approximately 8.2 acres per animal-unit month, although the ranges are now stocked at the rate of about 6.0 acres per animal-unit month. Over the past 30 years the trend in condition has been downward on 75 percent of the Indian ranges, and there has been improvement on about 10 percent. During approximately the past 5 years the trend has been downward on 63 percent, and there has been improvement on about 4 percent of the total range area.

ADMINISTRATION OF INDIAN RANGES

The record prior to the organization of the forestry unit in the Bureau of Indian Affairs in 1910 does not indicate that any considerable attention or systematic effort was given to the supervision of Indian range lands, even though in 1891 the leasing of Indian lands for grazing purposes was authorized by law. Indeterminate numbers of livestock made seasonal or yearlong use of the range, largely on a trespass basis, and the various efforts toward interesting the Indians themselves in the livestock industry met with varying degrees of success.

For 6 to 8 years after 1910 some attention was given to the range situation in the Southwest by the forestry unit of the Indian Service.

A system of range allocation was inaugurated, and fees were collected for grazing privileges. This work was subsequently turned over to the various reservation superintendents, and thereafter but little real progress in range control was made. Some years later, but prior to 1920, as forestry organizations were developed on the reservations of the Northwest, the responsibility for the supervision of grazing activities was gradually assumed on the more important forested reservations of this region. Range lands were organized into grazing units, a permit system with a definite control of the number of stock and season of use was adopted, and an orderly program of management was placed in effect (*164, pp. 607–632*). As a result of the progress made in range administration on the reservations of the Northwest and of the growing recognition of the importance of range conservation, the supervision of all grazing activities on Indian lands was delegated to the forestry branch in 1930.

A definite and systematic program of range management for application on all reservations was initiated, directed toward the conservation and regulated use of range resources. To the extent allowed by the funds available, a technically trained personnel has been developed for range administration. The objectives were definitely stated in the grazing survey report previously cited, and were approved by the Secretary of the Interior June 4, 1931. In abbreviated form, they are as follows:

1. The preservation of land, water, forest, and forage in a safe and entire state.

2. The permanent welfare of the livestock industry generally and the Indian livestock industry in particular.

3. The protection of the interests of the whole Indian people against unfair competition by the more aggressive individuals.

4. The conservative utilization of all forage resources, primarily through the development of the livestock industry among Indians, and secondarily through the regulated sale of grazing privileges.

On the forested reservations of the Northwest these regulations served to strengthen the plan of administration already in operation, and but little modification of range-management practices was required. On other reservations used largely by white-owned stock there was considerable opposition, both on the part of the Indians as landlords (*161*) and the livestock operators as lessees, to the inauguration of this more positive system of range management.

Much more encouraging progress has been made on the ranges used by white operators than on ranges used by the Indians themselves. In the Southwest, although many thousands of sheep and goats have been removed from the Navajo ranges and constant effort for further improvement is steadily being made, progress toward sustained-yield management has been relatively slow. An extension program directed toward improving their knowledge and understanding of range management has been instituted among the Navajos as a part of the plan for gradually reducing the number of stock on the overgrazed ranges. The problem of the administration of Indian range lands, with its many ramifications, has by no means been solved, but definite steps toward sustained-yield management have been taken, and further progress seems assured.

SPECIAL HANDICAPS IN ADMINISTRATION

LAND STATUS

The governmental policies which have been applied with respect to Indian lands have resulted in a highly involved land status on some of the reservations today which has greatly complicated management of the range resources. From colonial days until recently the friends of the Indians, without exception, tried to lead, persuade, or force them into the settled domestic mode of living which the white man had developed and which has proved so satisfactory to him. A permanent home instead of a nomadic life, a family group instead of a tribal band, domestic livestock instead of wild game, and individual instead of communal ownership of land, were considered to be necessary for the proper development of the Indian.

In carrying out these principles the Indians were encouraged to make selections of land on their reservations and these selections were then conveyed to them as allotments. When the Indians of a reservation had each been allotted land for homemaking and tribal reserves of timber and grazing grounds had been made, the surplus lands were in many instances opened to homestead entry or disposed of in other ways with the proceeds of disposal credited to the tribal funds.

Many variations of this land program were applied on the numerous reservations in the Northern States, and as a result much land unsuited to individual development has been passed into private ownership. In the Southwest, owing to the stronger communal traits of the Indian people and the more obvious unsuitability of the reservation land for use in small tracts, this land-disposal program was not so generally applied.

As a result of the various land transactions within the boundaries of many reservations there are five distinct classifications of land ownership:

1. *Ceded and alienated.*—Lands to which the Indian title has been completely extinguished by Executive order, Federal purchase or comparable governmental action.

2. *Alienated allotments.*—Lands in homestead size tracts to which patent in fee simple has been issued to individual Indians and which may still remain in Indian ownership or may have been disposed of to whites. Such lands are subject to taxation and sale and are in every sense private property.

3. *Ceded but unentered.*—Lands ceded by the tribe to the Federal Government for disposal by the General Land Office. Indian title will not be extinguished until homestead entry is approved and proceeds paid into the tribal fund.

4. *Trust allotments.*—Lands in homestead size tracts to which patents have been issued to individual Indians with restrictions as to alienation or encumbrance.

5. *Tribal.*—The undivided community-owned lands of the tribe.

The extent of holdings under the various status classes in 1931 were as follows:

	Acres
Ceded and alienated	10,775,263
Alienated allotments	3,897,012
Total	14,672,275
Ceded but unentered	1,812,205
Trust allotments	18,639,641
Tribal lands	30,051,979
Total	45,408,825
Grand total	[1] 60,076,100

This highly involved and decentralized ownership of land, which for purposes of effective and efficient range management should be handled in large consolidated blocks, constitutes one of the most trying problems of Indian range administration.

INDIAN RIGHTS AND PRIVILEGES

In addition to the intricately involved land status, there are several other problems peculiar to the administration of Indian lands, all deriving from the premise that "the least government is the best government" and that the Indians are entitled to a wide discretionary latitude in the handling of their own property. Because of this policy, Indians have not been prevented from grazing semiwild and almost worthless ponies yearlong on seriously depleted spring ranges. The desire to encourage the Indians in the ownership of sheep and cattle to develop economic independence and habits of industry has resulted in the minimum of restrictions on overgrazing, poor distribution, and other bad range practices.

The importance of income from the grazing use of individual allotments has been a further serious source of difficulty in range administration. The right of each individual Indian to obtain the highest possible current income from his property and the implied responsibility of Indian Service employees to support this procedure tended for years toward inadequate control of stocking and overuse of the range. The consolidation of Indian allotments into range units and the application of the permit system, accomplished under the grazing regulations of June 4, 1931, have been of major importance in improving this situation.

WHEELER-HOWARD ACT

It is too early in the operation of the Wheeler-Howard Act (June 18, 1934)—the most notable recent legislation with respect to Indian affairs—to make a conclusive appraisal of its ultimate effect on Indian range lands. However, certain of its features are extremely important in connection with range-land management.

The explanatory title of the act indicated its scope:

> To conserve and develop Indian lands and resources; to extend to Indians the right to form business and other organizations; to establish a credit system for Indians; to grant certain rights of home rule to Indians; to provide for vocational education for Indians; and for other purposes.

[1] This acreage includes all Indian lands in the United States and therefore does not agree with the total acreage in the western range area.

The first four sections of the act deal with land status and ownership and are directed toward restricting the further alienation of Indian land to the irreducible minimum consistent with proper inheritance procedure. This will operate toward the stabilization of the ownership of Indian land in its present status and, together with the authorization for consolidation and acquisition contained elsewhere in the act, should have a helpful influence in range conservation.

Section 6, in which range management is specifically mentioned, reads as follows:

> The Secretary of the Interior is directed to make rules and regulations for the operation and management of Indian forestry units on the principle of sustained-yield management; to restrict the number of livestock grazed on Indian range units to the estimated carrying capacity of such ranges, and to promulgate such other rules and regulations as may be necessary to protect the range from deterioration, to prevent soil erosion, to assure full utilization of the range, and like purposes.

This section makes the protection of Indian range lands and the application of sustained-yield management a definite mandatory responsibility of the administrative organization, but, since in each case of serious overgrazing on Indian lands the stock is owned by the Indians themselves, a much more complex procedure is involved than the mere modification or cancelation of a grazing permit. In fact, it would seem to involve a modification of lifelong habits and customs and the substitution of some other means of procuring a livelihood for a large percentage of the Indian population in the Southwest. Social and economic development must go hand in hand with the application of the conservation features of the Wheeler-Howard Act. If so, in the ultimate application of these conservation features, the Indians themselves as well as the Indian ranges will be greatly benefited.

PROBLEMS

The variation from time to time in the social aims and objectives of Indian guardianship by the Federal Government, the peculiar desires and habits of the Indian himself, the complicated pattern of land status within the reservations, and the failure for a long time on the part of administrative agencies to recognize that conservation and sustained yield of the range resources are fundamental to the future social and economic development of the Indian have resulted in a variegated pattern of accomplishment in conservation of the Indian-range resources. There has been severe depletion of the range forage, especially in the Southwest. On the forested reservations of the Northwest where the forestry unit of the Indian Service assumed responsibility for the supervision of grazing activities prior to 1920, the ranges are in reasonably good condition. Finally, in 1930 the supervision of all grazing activities on Indian lands was delegated to the forestry unit and a positive program of range conservation was started. The many problems have by no means been solved but sustained-yield management has now been initiated and further progress seems assured.

Among the more important problems still to be dealt with are: Further reduction in numbers of livestock on many of the reserva-

tions and especially in the Southwest; the development of more adequate range-management plans; the installation of needed range improvements, range reseeding, and control of soil erosion; insofar as possible, the readjustment of the complicated status of land ownership inside the reservations; and improving the knowledge and understanding on the part of the Indian of the importance of range conservation and how to accomplish it.

The Grazing Districts

Approximately 162 million acres of unreserved unappropriated public domain remained in the United States on June 30, 1934—practically all of it in the 11 Western States. This is the last "picked over" remnant of the once vast acreage of free public land, which except for 65 million acres now being organized for administration under the Grazing Act is a no man's land so far as conservation and orderly use of its resources are concerned. In addition, there also were on June 30, 1934, approximately 29 million acres of other Federal land in withdrawals for reclamation, preservation of oil, oil shale, coal, and minerals, and for other special purposes which, so far as grazing is concerned, is in the same status as the remaining unreserved public domain. The grazable range area involved is approximately 60,567,000 acres in the grazing districts, 67,224,000 acres in the unreserved public domain, and 22,996,000 acres of other Federal lands. The forage resources on this land including that in grazing districts as shown in table 54 have been depleted approximately 66 percent as compared to virgin condition and the soil and watershed values have been greatly impaired. The use of the land for wildlife conservation has been greatly reduced. The lack of regulation has led to serious social and economic maladjustments.

Although the need for regulation to conserve and wisely use these resources has been recognized for many years and efforts to obtain action have been aggressively urged since late in the last century, nothing was done about it until recently. In June 1934 the Grazing Act was passed, but only after opposition which forced amendments that greatly lessened its value as an instrument for the solution of one of the Nation's major conservation problems.

TABLE 54.—*Degree of depletion of virgin range in plant types on the combined usable range area of grazing districts, unreserved public domain, and minor Federal reservations*

Plant type	Total area[1]	Moderate depletion (26–50 percent)	Material depletion (51–75 percent)	Severe depletion (76–90 percent)	Extreme depletion (91–100 percent)	Average depletion
	1,000 acres	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*
Tall grass	147	100				10
Short grass	12,005	6	44	43	2	49
Pacific bunchgrass	2,203		31	48	21	65
Sagebrush grass	10,000	2	24	39	16	60
Saltbrush grass	11,221	1	10	32	57	69
Southern desert shrub	7,504		17	28	55	64
Salt desert shrub	11,117		10	17	73	73
Pinyon-juniper	10,000	3	3	23	71	71
Woodland-chaparral	1,000		67	33		31
Open forest	4,074	11	26	48	14	34
Total or average	169,000	3	15	28	25	49

[1] Includes areas of usable range closed to grazing for various purposes.

FAVORABLE FEATURES OF THE GRAZING ACT

The title of the Grazing Act lists as its purposes:

> To stop injury to the public grazing lands by preventing overgrazing and soil deterioration; to provide for their orderly use, improvement, and development; to stabilize the livestock industry dependent upon the public range; and for other purposes.

The Secretary of the Interior is authorized, in his discretion, to establish grazing districts, aggregating not to exceed 80 million acres, out of the vacant, unappropriated and unreserved lands of the continental United States, exclusive of Alaska. The objects of the grazing districts are stated to be "to regulate their occupancy and use, to preserve the land and its resources from destruction or unnecessary injury, to provide for the orderly use, improvement, and development of the range." The Secretary is directed to "make provision for the protection, administration, regulation and improvement of such grazing districts as may be created, * * *" and to "make such rules and regulations and establish such service, enter into such cooperative agreements, and do any and all things necessary" to accomplish the purposes of the act and to insure the objects of the grazing districts, and is authorized "to perform such work as may be necessary amply to protect and rehabilitate" the grazing districts. The Secretary is further directed to "specify from time to time the number of livestock that shall graze within a district and the seasons when a district shall be used for grazing" and to fix or determine reasonable fees for the use of the range.

It would appear to be clear from the foregoing provisions that the Secretary of the Interior has broad discretionary power to do whatever is necessary, subject to appropriations for such purposes, to perfect administrative machinery, establish necessary rules and regulations, construct range improvements, regulate the use, and do whatever else is necessary to stop injury from overgrazing and to conserve all the resources on the public lands set aside as grazing districts.

The act also provides for the exchange of State or privately owned land within a grazing district for public land on the basis of equal value. Thus opportunity is afforded to clear up situations where intermingled privately owned or State lands otherwise would complicate administration.

The grazing districts are closed to homestead entry except tracts which are classified by the Secretary of the Interior as more valuable for farm crops than for native forage plants. Supplemental to the Grazing Act, all of the remaining unreserved unappropriated public domain has been withdrawn from entry under the nonmineral land laws pending classification. Consequently, until the Executive withdrawal is modified, public-domain lands are no longer subject to disposal under the homestead laws.

SHORTCOMINGS OF THE GRAZING ACT

Accomplishment of the purposes and objects of the Grazing Act may be greatly hampered or even defeated by certain weaknesses in the law. The act contains several restrictive clauses; others are ambiguous or conflicting and will require interpretation in the courts before a clear understanding is possible. At least, until these clauses

are judicially construed, contentions and differences of opinion will handicap the making of administrative decisions and will impede, if not prevent, real accomplishment in conservation and use of the resources. Much will depend also upon the policies for administration which are adopted under the broad discretionary powers delegated by the act. A clause in the opening sentence, "pending its final disposal", weakens the structure of the whole act. It implies that administration is only temporary and discourages far-sighted aims and objectives and initiation of the kind of action essential to the proper protection and conservation of the resources. It appears to make clear that the intent of the act is to dispose of these lands in the reasonably near future. The whole history and experience with this land has been that it is unsuited to private ownership and should remain in the jurisdiction of some public agency financially and administratively qualified to cope with the problems of management.

The maximum of 80 million acres authorized to be included in grazing districts is only approximately one-half the public land needing attention. At best, therefore, the present problem is only half met.

RELATED RESOURCES NOT RECOGNIZED

No specific provision is made for the protection of watershed values in order to control the menacing erosion or reduce the serious floods which originate on this land, beyond that which may be accomplished by revegetation and improvement for grazing purposes, or for the development and use of the other resources—more especially game, wood, and recreation. On the other hand, the act is so explicit throughout with reference to use and development of the land for the grazing of livestock that there is bound to be strong and persistent contention that the act is designed wholly for the welfare of the livestock growers, or at least is so colored that great difficulty will be encountered in interpreting it otherwise. If the task involved no more than restoring the meager grazing resources, it might be argued that the land had better be abandoned without attempting conservation. But this land cannot be written off the books and discarded like a worn-out piece of machinery. Depletion has brought excessive run-off and water or wind erosion almost everywhere. Fully 50 percent of the usable range land comprises parts of watersheds or is otherwise so situated that floods and silt are destructive to power and irrigation development and to adjoining land, and are making increasingly difficult the maintenance of highways and railroads across this vast domain. The breeding, on depleted public domain range lands adjoining agricultural sections, of insects injurious to farm crops promises to become a serious problem unless the present host plants, which have come in as the result of overgrazing, are replaced. These various consequences extend to areas and values far beyond the limits of the land itself.

The grazing-district lands, in addition to producing forage for domestic livestock, afford other important possibilities of use. They constitute the natural feeding place or breeding grounds, or both, for various species of game animals and birds. Some areas support woodland or forests which are an important source of fuel and building material for local use. Still other parts have high potential

value for outdoor recreation and the human enjoyment of desert flora, geologic forms, and scenery.

In order to realize the maximum contribution to local communities and the general public welfare, there should be correlated use, protection, and development of all of the resources on the grazing districts so as to obtain the highest net benefit from all combined, in accordance with actual present and probable future needs. Perhaps this can be accomplished under the broad authority conferred upon the Secretary of the Interior.

LIMITATIONS ON TRANSFERS OF LAND FROM GRAZING DISTRICTS TO NATIONAL FORESTS

The act provides for the transfer of any lands within national forests chiefly valuable for grazing which can best be administered as grazing districts. There are several million acres of land now in national forests which perhaps might be administered under either the act of June 4, 1897, governing the national forests, or the Grazing Act of June 28, 1934. However, since the Grazing Act greatly restricts action to conserve and wisely use the resources of the land, certainly no good purpose could be served by placing in the grazing districts land now under national-forest status, which has been effectively and satisfactorily administered for a quarter of a century.

Moreover, the Grazing Act should have provided for the transfer of any lands in grazing districts or the open public domain which adjoin and form integral parts of timber bodies, watersheds, and range units largely within national forests.[24]

There are approximately 26 million acres of forest range land in the unreserved public domain and grazing districts in the Western States which should be added to the national forests in order to simplify administration, and devote the lands to the purposes for which they are chiefly valuable. It would also be possible for users of a single economic unit, now divided under two Federal jurisdictions, to deal with a single administrative agency. This would still leave approximately 1,000,000 acres of isolated tracts of forest range land for administration under the Grazing Act.

LIBERAL SALE OR LEASE OF ISOLATED TRACTS OF PUBLIC LAND

Scattered practically throughout the more solid blocks of privately owned range land in the West are isolated tracts of public land of a few to several thousand acres in area, aggregating upward of 10 million acres or more, which cannot readily be administered as parts of grazing districts. Most of them are submarginal for private ownership, or title long since would have passed.

The Grazing Act provides for the leasing of such isolated or disconnected tracts or parcels of 640 acres or more in area to owners of contiguous lands, under such terms and conditions as the Secretary may prescribe. It also provides that such tracts, not exceeding 760 acres in area, may be sold at public auction when in the judgment of the Secretary of the Interior it is proper to do so. Still another provision in the act authorizes the sale of legal subdivisions of public land not exceeding 160 acres unsuited to cultivation, to own-

[24] Utah, South Dakota, and Nevada are the only States where, at present, national forests may be created or enlarged by Executive order.

ers of adjoining land regardless of whether the tract is or is not isolated or disconnected. These provisions in the act may be administered so as to safeguard the public interest. On the other hand, if administered in accordance with the past policies and traditions of land disposal in the United States, they may become an effective means of defeating the purposes of the Grazing Act, jeopardizing the public interest on several million acres of public land, besides adding to the present excessive burden of private ownership of range land.

Within the limits of the railroad land grants, for example, where the odd-numbered sections are alienated, the alternate sections, the large majority of which in many localities still belong to the Government, are isolated tracts within the meaning of the law. In Nevada the odd-numbered sections in a strip approximately 320 miles long and 40 miles wide were granted to a railroad company and most of the even-numbered sections still belong to the Government. If leased to the railroad companies, which are the owners of the contiguous land, it would be physically almost impossible to enforce requirements to protect the range and prevent overgrazing of the intermingled public land. The control would largely be in the hands of the present owners or lessees.

FUNCTIONS OF RANGE OUTSIDE

The grazing-district land in the main is basically unfitted for development and use independent of lands in other forms of ownership or control. This public range is needed primarily to supplement tilled forage-crop lands and range lands in other forms of ownership and control to the end that satisfactory rounded-out operating units involving all classes of agricultural land will be achieved. Accomplishment of this aim is complicated by the highly unsocial and uneconomic land-use situation which has developed under the inadequate land-disposal policy of the past. Under the system of economic and physical competition which has existed on the open public domain, the more aggressive stockmen in numerous instances have been able to crowd out their weaker neighbors and to monopolize the watering holes and better areas of range.

For example, in one Western State having a large acreage of unregulated range, past practice has permitted the larger livestock interests to acquire from the State land and water which might have been used to better advantage in production of cultivated forage crops to supplement the public range. This land they have utilized chiefly for the inefficient production of wild hay and to control large areas of public range to the exclusion of diversified agriculture. In 1916 one writer (*6*) stated, "Instead of numerous small farms cultivated by their owners, we see great land holdings owned largely by corporations and managed in such a way as to create conditions unfavorable to the welfare of the laborers and the public." The situation has changed but little since that time. To bring about the needed adjustments in land use and ownership involves the application of sound forward-looking social and economic principles in the administration of the Grazing Act.

In this connection, with reference to the issuance of permits for the grazing of livestock, the act provides that:

> Preference shall be given * * * to those within or near a district who are landowners engaged in the livestock business, bona-fide occupants or settlers, or owners of water or water rights, as may be necessary to permit the proper use of lands, water or water rights owned, occupied, or leased by them. * * *

To the extent that this clause provides for such an integration of public lands with other grazing and forage-crop lands of a locality as will result in the highest use of all the land, it specifies a highly desirable objective. However, to attach the grazing privilege to the land, water, or water rights in a manner to permit their "proper use" regardless of all other circumstances would result in dividing the available public-range resource and attaching it in proportional quantities to all of the owned land or water with which it might properly be used. To do so would perpetuate and enhance existing monopolies in land use which have been established in many instances by the stronger individuals taking advantage of their weaker neighbors.

Take, for example, a locality where neighboring small settlers and large-sized livestock outfits, each owning or leasing land and water in equal proportion to the number of livestock they own, all use in common a public range having insufficient grazing capacity properly to use all of the land and water owned or leased by them; the small operators under such conditions and under a possible interpretation of the law would be required to reduce their number of livestock in the same ratio as the large operators, regardless if to do so would impoverish the small operators; it would be impossible under such circumstances to impose proportionally heavier reductions on the larger outfits in favor of the small settlers in order that the latter might continue to maintain their standard of living from the land and livestock. In other words, the act appears to give preference to existing property rights rather than to human needs in the distribution of public benefits.

In Nevada where most of the springs and streams are held by the ownership of small tracts of privately owned land or under the livestock-water law of that State, this clause in the Grazing Act might be construed as granting to such holders the use of all the surrounding public range land that might be necessary to permit the proper use of the available water. In that event, the old practice of controlling large areas of public domain by the ownership of a few acres of land strategically located, would be confirmed by law.

The use of public range in connection with leased land or water, is theoretically commendable to the extent that it would help the small owner to enlarge his grazing preference and in that manner improve his standard of living. But this also is a double-edged sword. The larger resident operator or transient stockman frequently is the stronger competitor and higher bidder for lands offered for lease. Moreover leasing gives the absentee property owner benefits which more properly should be given to local residents who need them to maintain permanent homes in the locality where the public range is situated. Therefore, it appears not to be in the interest of improving local social conditions to give equal consideration to leased and owned land in distributing public-range privileges.

DANGER OF RANGE RIGHTS BECOMING ESTABLISHED

Several provisions of the Grazing Act contain language which might be construed as a grant to favorably situated stockmen of indefeasible rights and privileges in the use of forage and related resources on grazing-district lands, even though the exercise of these rights and privileges prevents an equitable allotment of such resources. For example, section 1 contains the following provision:

> Nothing in this act shall be construed in any way to diminish, restrict, or impair any right which has been heretofore or may be hereafter initiated under existing law validly affecting the public lands, and which is maintained pursuant to such law except as otherwise expressly provided in this act. * * *

At the end of section 3 it is further provided that—

> So far as consistent with the purposes and provisions of this act, grazing privileges recognized and acknowledged shall be adequately safeguarded, but the creation of the grazing district or the issuance of a permit pursuant to the provisions of this act shall not create any right, title, interest, or estate in or to the lands.

While persons hitherto using the range involved did so under a sort of implied license without acquiring a vested right thereto, the provisions of the act quoted above, although aimed to deny the creation of right in the land itself, imply a right of user amounting to a property right which the Secretary of the Interior cannot disturb. Should it be so construed, his administrative control of such land as elsewhere provided in the act would be seriously hampered, if not defeated, and he would therefore be compelled to suffer a continuation of present conditions regardless of what the public interest might require in bringing about properly regulated management.

There can be no doubt as to the intent of that part of section 3 reading as follows:

> * * * except that no permittee complying with the rules and regulations laid down by the Secretary of the Interior shall be denied the renewal of such permit, if such denial will impair the value of the grazing unit of the permittee, when such unit is pledged as security for any bona-fide loan.

Obviously the limitation placed on the powers of the Secretary of the Interior by this provision may be used by permittees materially to restrict, if not wholly to defeat, adjustments in range use that are necessary if grazing privileges are to be equitably distributed in the interest of home and community development or for the purpose of improving and protecting the range. There are very few livestock or ranch properties which do not continuously constitute security for a loan, the value of which would be impaired in varying degrees by denying the owner a renewal in full of his permit. This provision discriminates against the owner who happens to be free of debt when he applies for a renewal and—most important—makes it possible for any permittee to continue his exclusive use of the range and obtain other undue advantages by simply using his livestock and ranch property as security for a loan, the amount of such loan apparently being immaterial. In short this provision enables permittees very easily to perpetuate their monopoly regardless of how adversely such perpetuation affects the interests of the community and the general public.

The dangers involved in the establishment of rights in public resources is illustrated by the accumulated experience of Europe (27). There the public interest has suffered in three ways: Large

areas of forest, both public and private, have been needlessly destroyed or severely damaged; the progress of agriculture has been held back by the perpetuation of uneconomical land use and stock-raising methods; and the rights themselves have been the source of much wasteful litigation and ill feeling. Despite the struggle going back over several centuries to extinguish these rights, many are still in existence. About the only way the situation can be met is by outright purchase and then only where the holder agrees to the bargain, except when there is cause to exercise the right of eminent domain. There is grave danger that the safeguarding of privileges to use public domain as set forth in the Grazing Act at the present time, if allowed to remain will eventually become more securely fixed by right of long usage.

In the United States, the fixing of rights to use the range is seen to have highly undesirable features at the present moment, but it may become a more serious menace in the future. Vested rights in Europe originated when forests were abundant and pasturage was scarce, and under such circumstances damage to the forest was of less import. With time the situation was reversed and grazing rights have become a real handicap to meeting the needs for timber. A similar reversal of conditions may develop in this country. As the needs for protection and use of the land for watershed purposes, game, and recreation multiply, the fixing of rights on the grazing districts will seriously interfere with these purposes. Quite as important also is the lessening by fixing of rights of the opportunity to correct the uneconomical land use which has grown up in the West.

COMPLICATIONS WITH STATE LAWS

If the States fully exercise the jurisdiction expressly conferred on them by two provisions of the act, the Federal Government may find it impossible to administer grazing districts in an effective manner. The first of these provisions is found in section 1 and provides that nothing in the act shall be construed in any way "as limiting or restricting the power or authority of any State as to matters within its jurisdiction." The other is contained in section 16, which reads as follows:

SEC. 16. Nothing in this Act shall be construed as restricting the respective States from enforcing any and all statutes enacted for police regulation, nor shall the police power of the respective States be, by this Act, impaired or restricted, and all laws heretofore enacted by the respective States or any thereof, or that may hereafter be enacted as regards public health or public welfare, shall at all times be in full force and effect: *Provided, however*, That nothing in this section shall be construed as limiting or restricting the power and authority of the United States.

These two provisions are ambiguous and might be construed to mean that existing and future State laws will apply to grazing districts established under the Grazing Act and will prevail over any conflicting or inconsistent regulation of the Secretary of the Interior. If so construed, regulatory control over these districts thus in large measure would be turned over to the several States and the authority of the Secretary of the Interior would be so limited that he could not take any action with respect to the grazing districts

which conflicts with State law, particularly if the proviso at the end of section 16 is strictly construed. However, since the legislative intent reflected in this section and in the last sentence of section 3 is not clear, it is not yet possible to determine accurately how such provisions will be interpreted. Therein lies one of the major difficulties of the act. Many parts are so ambiguous and so conflicting that controversies are bound to occur until such time as the act has had judicial interpretation.

RANGE ADMINISTRATION BY STOCKMEN

Obviously much will depend upon the kind of administration developed under the broad provisions of the act with respect to meeting the needs both of those dependent upon the range and the broader public interest. Section 9 stipulates that the Secretary of the Interior "shall provide, by suitable rules and regulations, for cooperation with local associations of stockmen, State land officials, and official State agencies engaged in conservation or propagation of wildlife interested in the use of the grazing district." This provision is a favorable feature, resembling that adopted under rules and regulations applying to the administration of grazing on the national forests, in that it recognizes the desirability of giving the user an advisory voice in local affairs and induces voluntary interest in the range. Whether or not it should be made the main instrument of administration seems doubtful.

Rules have been adopted by the Department of the Interior specifying the procedure under this clause which provide for the selection of stockmen representatives[a] for all grazing districts and for wildlife and recreational representatives in one of the western States, New Mexico.[b] In commenting on the procedure for selecting stockmen representatives, the Annual Report of the Secretary of the Interior for the fiscal year ending June 30, 1935 (p. 16), states as follows:

> * * * the services of local persons familiar with the range problems will be secured by a special election of district advisors from among local stockmen. * * * By this means the practical local viewpoint will be available at all times in the administration of the law. * * * They will take the regular oath of office of a Federal official and will be the local governing agency as to all matters of range regulatory nature concerning their particular district. The Interior Department will exercise necessary supervision and provide basic technical criteria for conservation of natural resources.

This no doubt is an indication of the intended form of administration. It places the large balance of power in the hands of the livestock interests and leaves to the Government representatives the mere exercise of supervision and to "provide basic technical criteria" for use by the stockmen.

To grant to the stockmen the major controlling power in the administration of the grazing districts implies that they will exercise the necessary self-restraint and denial in immediate use and misuse for the sake of the permanence of the range, something rarely

[a] United States Department of the Interior, Division of Grazing. Rules Providing for Special Elections for District Advisers to Assist in Management of Grazing Districts. U. S. Dept. Int., Dept. Grazing Circ. 1, 8 pp. 1935. [Multigraphed.]

[b] United States Department of the Interior, Division of Grazing. Special Rules for Grazing Districts in New Mexico. U. S. Dept. Int., Dept. Grazing Circ. 2, 2 pp. 1935. [Multigraphed.]

exercised on their own lands. Conservation of the resources requires a large fund of technical knowledge of a difficult problem and cash outlays to restore productivity. It involves a high degree of public spirit to forego range use and the denial of personal profit in order to realize on public values in watershed protection and game conservation, which may be considered by the individual stockman to be of little if any direct benefit to him. There must be cooperativeness in an unusually high degree to prevent individuals holding positions of power from using them to their own immediate advantage. All these are the very antithesis of the doctrine of laissez faire which has resulted in the present condition, not only of the grazing-district range itself but of the bulk of the area of privately owned and State lands throughout the West.

What is needed, in addition to the cooperation of all classes of users and full opportunity to express their voice in an advisory capacity, is a well-planned, closely knit, positive administration with adequate technical skill which will give full consideration to the broader community, State, and interstate public interest as well as to the local livestock industry.

The problem of stopping damage and restoring the grazing capacity of the grazing districts is highly difficult and technical, because of the serious depletion, adverse soil and climatic conditions, and low productivity. It will involve heavy reductions in the numbers of livestock grazed and management from more than a short-sighted viewpoint. Other essentials are the protection of watersheds, conservation of game, and the development of the use of the resources other than livestock forage. Still another of the big tasks is to bring about the proper integration of use of the grazing-district land with other agricultural lands both inside and adjoining the grazing district, and to place the capacity of the land to support dependent populations ahead of large profits for a relatively few; problems having broad public aspects. It is doubtful whether these functions will be exercised under a system of administration of self-regulation by the stockmen who use the range.

Finally the Grazing Act sets up an agency in the Department of the Interior to deal with agricultural problems, whereas practically all other agricultural functions of the Federal Government, including administration of the national-forest ranges, are grouped in the Department of Agriculture. Another problem therefore is that of how best to unify responsibility for range administration in a single department of the Government.

Conservation on Privately Owned Range

Approximately 51 percent of all western range lands are in private ownership. According to estimates based on the best available information as shown in table 54a, only 12 percent of this land has been maintained or restored to within 25 percent of its virgin condition. The least depletion is found in the tall-grass and open-forest types; only approximately 5 percent of the total area of all the other types is in the moderate depletion class. Among the factors which have contributed to depletion, as pointed out in earlier sections of this report, are excessive stocking or other rule-of-thumb management, lack of legislation that permitted acquisition of land in units

best suited to proper use of land for range-livestock production, unsound financing, high interest, heavy taxation, poor marketing facilities, competition that compelled excessive ownership of land and inflation of land values, and other conditions some of which the private landowner has been unable to control. The privately owned range lands which are in the better condition class today are of especial interest in developing a program for the solution of western range problems.

TABLE 54a. *Degree of depletion of virgin range by plant types on privately owned lands*

Plant type	Area	Proportion of total ownership				Average degree of depletion
		Moderate depletion (0-35 percent)	Material depletion (36-50 percent)	Severe depletion (51-75 percent)	Extreme depletion (76-100 percent)	
	Thousand acres	Percent	Percent	Percent	Percent	Percent
Tall grass	17,271	73	24	0	4	29
Short grass	146,144	5	47	33	17	51
Pacific bunchgrass	12,913	8	59	30	4	50
Semidesert grass	46,426	5	30	33	6	44
Sagebrush-grass	24,791	7	9	36	48	71
Southern desert shrub	10,649	0	22	33	39	69
Salt-desert shrub	5,251	1	3	45	51	74
Pinon-juniper	21,905	5	30	43	20	55
Woodland-chaparral	10,449	3	45	33	9	51
Open forest	25,866	36	46	21	0	28
All types	375,546	13	37	36	15	51

The privately owned range lands which are exceptions to the more prevalent condition of serious depletion may be classified into four groups. These are (1) isolated cases of individual ranges in good condition within areas where, because of the prevalence of unfavorable natural factors, the general situation is one of depletion; (2) ranches or groups of ranches within regions where natural and other factors are more or less favorable, as in parts of the Great Plains; (3) ranges in areas where natural conditions practically dictate the continuous practice of range-conservation measures, as in the sandhills region of Nebraska, and (4) on privately owned lands in and adjacent to the national forests. These privately owned ranch lands in good condition have never received the thorough study they require in order to set forth with finality the contributing factors. This analysis, therefore, must be based on general knowledge and information. However, the results from a few examples are indicative.

WEST OF THE GREAT PLAINS

With few exceptions natural conditions west of the Great Plains render difficult the conservation of the range. The rainfall is low and often poorly distributed and droughts are frequent. Few of the native plant species or types are highly resistant to grazing and the grazing capacity is naturally low. The soil on extensive areas is easily damaged by trampling. The composition and char-

acter of the vegetation is such that damage to the range may occur long before it forces a reduction in the number of stock being grazed. The lack of control on the extensive open public domain has often caused pressure to overuse privately owned land. These are only a few of the adverse factors with which the private owner has had to deal. In spite of this general situation there are scattered ranch lands in good condition where the owners have successfully conserved the range.

Two or three range units on Kolob Mountain in southwestern Utah, for example, have been maintained in good condition as contrasted with severely depleted holdings adjoining them. The owners of the good ranges purchased their lands a good many years ago at relatively low prices and thus have escaped excessive interest charges on land indebtedness. They have stocked their ranges conservatively and the original cover of snowberry, mountain bromegrass, weeds, and other plants carry sheep through the summer season at the rate of two-thirds of an acre for each animal for each month. This is approximately a one-third higher grazing capacity than on some of the adjoining ranges, which have been overstocked. In the whole State of Utah there are perhaps a dozen such well-cared-for private ranges.

In Idaho at least one wool growers' association has done a creditable job of forage maintenance on most of its spring-fall range, a large part of which is leased from the State. The association has adopted rules limiting the number of stock to be grazed and the seasons of use, and practices deferred and rotation grazing. The enterprise has been handled under the guidance of one or two progressive stockmen who have foreseen the value of sustained-yield range management. The net result of these factors is that the range is far above average in condition.

In California a number of ranches are used continuously for range—some for over 50 years—on the basis of sustained yield of forage. Seasonal deferred and rotation grazing has been practiced. Distribution of stock has been improved by fencing and water developments. One ranch in Marin County once badly depleted has been brought virtually to its pristine condition. A strict type of deferred grazing was followed. The unit was well balanced, and the operator devoted all of his time to his ranching business.

In Humboldt County, Calif., a 40,000-acre ranch, used for livestock production for 50 years, still supports a maximum stand of California oatgrass. The area is an economic and balanced unit. The operator has been careful not to overgraze and has practiced deferred grazing. He has not expanded speculatively.

An old Spanish land grant in Colorado is now being managed under deferred and rotation methods of grazing, and stocked conservatively so as to restore the original carrying capacity that was seriously depleted by former lessees.

The reasons for the individual cases of privately owned ranges in good condition west of the Great Plains, which represent probably less than 5 percent of all range lands in private ownership in that area exclusive of those in and adjacent to the national forests, may be summarized as follows: (1) Reasonable cost of range land, either purchase cost or rental; (2) well-rounded-out operating units;

(3) close personal attention to use of the range; (4) the application of some of the fundamental principles of range management; and, (5) most important of all, an appreciation that conservative use of the range to maintain yield of forage is the foundation to sustained livestock production.

THE GREAT PLAINS

In the Great Plains short-grass type naturally favorable factors have contributed much to the 8 percent of privately owned range in that type that is in good condition. Within this region rainfall is 15 to 20 inches and a relatively larger proportion of it falls during the growing season than further west. The dominant vegetation over large areas is grama, buffalo, western wheatgrass, sedges, and other sod-forming species which are relatively resistant to grazing, trampling, and drought, and recover quickly from set-backs if given reasonable opportunity, as compared with the bunch grasses and other species which occur in many western range plant types. The land, on the whole, is flat to rolling, and watering places may be developed relatively cheaply—factors which favor good distribution of livestock on the range. In many localities these favorable factors are offset in some degree by light soils which are low in productivity or are easily damaged by trampling. Prudent management also has contributed to the ranges which are in good condition in the Plains region, but on the whole the more favorable natural factors have been the dominating influence.

Sarvis (*119*) has found in his work at the northern Great Plains field station near Mandan, N. Dak., that under a very heavy stocking of one steer to 5 acres as compared to a proper stocking of one steer to 7 acres during the same grazing season the decline in range takes place very slowly and that after 19 years the grazing capacity had declined only 46 percent on the overgrazed range. His studies show that due to the recuperative capacity of the grasses almost complete recovery took place where all of the grasses had not been destroyed, in 1 or 2 years of average or better rainfall with complete rest or moderate to light use. He reported very marked improvement during 1935 on extensive areas of privately owned land in western North and South Dakota following the almost complete removal of livestock on account of the 1934 drought.

Sarvis' studies and Hurtt's (*76*) in Montana both show that cattle do not make as good gains on overstocked as compared to properly stocked range. In other words, overuse of the range in the Great Plains is quickly reflected in the condition of livestock—a reversal of the situation on many range lands further west—which encourages more conservative stocking when the aim is to obtain maximum weights of animals at marketing time.

The Pumpkin Creek-Mizpah grazing district in Montana is an example of the improvement in range lands obtainable where favorable natural conditions are coupled with the practice of range management by progressive stockmen. Although conditions are not as favorable here, as on many other parts of the Great Plains, the combination of good rainfall distribution, soil, and character of vegetation is better for maintenance of the range than where bunch grass

is the chief forage. The present association range of approximately 100,000 acres grew out of a desire of the users of the area to solve an almost impossible land-ownership pattern which had grown out of the past land policy and to stabilize the cost of range feed.

Forty-one percent of the area was railroad grant lands, 25 percent open public domain, 6 percent State, and 28 percent privately owned land in small tracts. The major object of the legislation establishing the grazing district was to coordinate all of these ownerships into an integral unit of range land. The key to control was the public domain, which under the permissive policy of the Government was open to use by all and subject to regulation by none. The 75 percent of non-Federal lands represented most of the grazing capacity within the area.

The act authorizing the withdrawal of the public domain contained an important section providing for cooperation between all interested agencies and landowners. Coordination was effected through organization of the users into an association which leased the railroad land, exchanged the State land for Government land, leased or offered to lease the small privately owned tracts, and purchased the tax-delinquent lands. The entire acreage was pooled so that it could be managed and administered as a community range.

Regulations for the administration and government of the area, adapted from those in effect on the national forest ranges, were framed by the association and approved by the Secretary of the Interior. They included the permit system, fees based upon the established rate per head as determined by the annual expenses of the association, allocation of use according to dependence of individual owners upon the range in order properly to utilize their owned range and crop land. An inventory of the range resources following Forest Service methods was made for use as a base in determining grazing capacity and a plan of management.

The plan of local administration and management has operated well, and persons familiar with the area report that the range has improved. Thus the naturally favorable factors, solution of an unsatisfactory mosaic of land ownership, the desire of a small group of stockmen with common interests to bind themselves together, and the adoption of simple principles of range movement applicable to the prevailing conditions have resulted in benefits to the whole community.

In the flint hills of Kansas and Osage hills of Oklahoma naturally favorable factors and the type of livestock production have resulted in the maintenance of the range. The 30 inches of rainfall and a soil formed largely from limestone, but too shallow to till, produces high forage yields. Rehabilitation in this type according to Dr. A. E. Aldous, of the Kansas Agricultural College, will take place under 2 years of rest and 2 years of moderate use if a small number of the original plants remain to start with. Moreover, much of the range is used for fattening steers on pasture which discourages excessive stocking because to do so results in poor gains in weight by the animals.

In Texas are found a number of large privately owned ranches, some of them in excess of 100,000 acres in area, have been improved by wells, reservoirs, and fences, and divided into seasonal pastures

and moderately stocked so that plentiful pasturage is supplied except in the severe drought years.

THE SAND HILLS OF NEBRASKA

The sand hills of Nebraska represent a unique situation because natural conditions have virtually dictated a policy of conservative use which has resulted in range preservation. Other factors have contributed, but they are secondary. This is a compact area of 11,520,000 acres on a low rolling sand-dune formation which has become fixed by the tall-grass cover located in the northwestern part of the State. The soil is a fine sand, subject to severe wind erosion when not protected by vegetation (*72*).

Early attempts at crop farming on 640-acre homesteads under the Kinkaid Act failed in this section. The fine sandy soil, once the vegetative cover was removed, became moving sand dunes. Taught by bitter experience the survivors consolidated their holdings into larger units, abandoned cropping practices, fenced their lands, and engaged in livestock production, based upon using about 80 percent of the land for pasture, 18 percent for native hay meadows, and less than 2 percent for crops.

Despite the delicate balance in which nature holds these lands, the climate, the native vegetation, and the absorptive capacity of the soil favor rehabilitation after depletion. Seventy-six to 80 percent of the 16 to 21 inches of precipitation falls between April and September and are readily absorbed. Forage yields are reduced by drought, but complete failures in forage production are unknown.

The soil dictates forcibly the methods of management which will maintain a plant cover. Overgrazing or prairie fires expose the sand to wind action and cause rejuvenation of blow-outs. Extreme care must be exercised to prevent trailing or undue concentration of livestock at water holes or wells because the depletion under abuse is rapid and conclusive. The one essential that must be observed is the maintenance of a covering of vegetation to prevent wind erosion.

Other factors have been helpful. The production of grass-fat beef or of fat feeders that may be finished on corn has encouraged light stocking to insure the best gains. Costs of production have been kept low enough to avoid pressure on the range. Favorable location and transportation facilities result in a short haul to market and opportunity to take advantage of the higher markets. However, conservative range use is the principal factor accountable for a restoration on privately owned land comparing favorably with that on the Nebraska National Forest, where the grazing capacity has been built up 55 percent since 1911.

PRIVATELY OWNED RANGE LANDS IN AND ADJACENT TO NATIONAL FORESTS

National-forest administration has had a profound influence on a large proportion of the privately owned range lands in good condition in the open-forest type (table 54a). Much of this land lies in and adjacent to the national forests. There are approximately 10.5 million acres of alienated grazing land intermingled with Federal land within the exterior boundaries of the national forests. The great bulk of this is privately owned land, the remainder being in

State or other public ownership. A far greater acreage of privately owned land in the open-forest type lies adjacent to the national forests.

Management of 3,677,000 acres of the alienated land inside the public forest boundaries is waived to the Forest Service. A still greater acreage, both inside and adjacent, is handled under the "on and off" permit system, the private land merely being handled as part of forest-range units. This has resulted in the privately owned lands being managed practically as national-forest range.

FACTORS WHICH HAVE FAVORED RANGE CONSERVATION

The best available estimates indicate that only 12 percent of the privately owned range land in the western United States have been maintained in good condition. These lands (see table 54a) are found chiefly in the sand-hills region of the tall-grass type in Nebraska, and in the open-forest-range type within and adjacent to the national forests of the West. In the short-grass type in the Great Plains, approximately 8 percent of the privately owned land is in good condition, and throughout the remainder of the West are found a few scattered tracts.

Natural favorable factors, such as better-than-average growing conditions, plant species which are resistant to grazing and have high recuperative capacity, such as the sod-forming species in the Great Plains, a firm soil, good grazing capacity, and conditions which favor good distribution of livestock on the range have played an important role in maintaining many of the private ranges in good condition. Still other contributing factors which have favored range preservation are low purchase cost and freedom from exclusive interest charges on land, low-cost public range in connection with privately owned range, good business management, well-rounded-out operating units, favorable location with regard to markets, and special-use range, such as that for grass fattening of livestock. That these natural and economic factors have contributed materially to the avoidance of range depletion is not to be minimized. However, the fact cannot be overlooked that there are, or at least were before range depletion occurred, a far greater number of privately owned or controlled range units on which most if not all of these factors are favorable than there are such units upon which the range has been maintained in good condition. Furthermore, there are units where, in spite of many of these factors being unfavorable, range depletion has not occurred.

To deliberate efforts to so use the range that the grazing capacity will be sustained must be credited the greatest measure of range maintenance on privately owned lands. There are individual owners who have learned from experience, as in the Nebraska sand hills, or for other reasons have come to realize that their range land is not an inexhaustible mine but that it must receive proper consideration in use if it is to continue to be a source of forage for sustaining livestock production. These owners have practiced conservative grazing and applied simple range-management practices in order to maintain their basic resource. There is no other single range region where range-livestock production is on as sound a basis as in the sand hills of Nebraska, where stern necessity early taught stockmen that conservative grazing pays.

V. ITS SOCIAL AND ECONOMIC FUNCTION

Before passing to a discussion of the steps required to halt further deterioration of the range, and to restore it to something approaching its original productivity and greatest public benefit, it is essential to evaluate what the range resource and its depletion mean to the West and to the Nation as a whole.

An appraisal of either the resource or its depletion is possible only in terms of their social and economic significance. The production of livestock, the water yield, and the income, pleasure, and diversion from the wildlife and recreational opportunities dependent on range lands mean nothing unless they add to human welfare; and on the other hand, reduced grazing capacity, floods and erosion, depletion of wild game, and impairment of recreational facilities carry no import unless they detract from the well-being and standards of living necessary to personal and national security.

To all of these products and services the vegetation on the range is the key. Without it, all the other benefits to mankind that range lands yield are void. With it livestock thrive, parched lands are watered, game and other wildlife have ample forage and cover, the natural beauty and grandeur of desert, plain, and mountain side are enhanced, and upon this renewable and self-perpetuating resource, more valuable than all the gold the West has mined, a thrifty and enduring civilization can be maintained. The purpose of this chapter is to review the functions of the vegetation cover of the range from the angles of watershed conservation, wildlife preservation, recreation, and the integrated agriculture of which the range is an inseparable part.

IN WATERSHED PROTECTION

By Reed W. Bailey, Director, and Charles A. Connaughton, Silviculturist, Intermountain Forest and Range Experiment Station

Preservation of satisfactory watershed conditions on range lands is vital to the well-being of the West and therefore is of concern to the entire Nation. Most towns and villages, many cities such as Los Angeles, Salt Lake City, and Denver, and innumerable ranches and farms rely on a usable and adequate supply of water produced wholly or in part on range-land watersheds. Irrigation enterprises representing investments of nearly 6 billion dollars depend on a stable soil mantle and stream flow from water-yielding ranges. Water power and recreation for multitudes of people are sustained in many cases by stream flow from range watersheds. A large population is dependent on the soil of range lands to produce forage upon which the 2-billion-dollar grazing industry and its source of income are based.

The range watershed situation presents three aspects: Eighty-five percent of the flow of important western streams comes from about 232 million acres, of which 79 percent is range lands. Silt is being borne down into these streams from erosion on approximately 352 million acres, practically all of which is grazed. Finally, much of the remainder of western range lands, such as those in the Great Basin and Great Plains, is eroding so seriously that it is imperiling productive capacity of the land, even though none of this eroded material is contributing to larger streams.

All this points clearly to the great importance of constantly maintaining an unbroken and productive soil mantle on all range land and the maximum yield of water from range watersheds; yet little thought has been given to the conservation of these values on other than the national forests and some municipally owned areas. Depletion of vegetation, as shown previously, has been the rule for the most part under other types of ownership or control, and with it have come floods and erosion menacing the social and economic security of the entire region. The destruction of soil and impairment of watershed values is without doubt one of the gravest results from misuse of the range.

Watersheds of the Virgin Range

The nature of the vegetation and soil mantle that clothed the watersheds of the virgin range, the normal course of stream flow, and the characteristics of natural erosion can be estimated from the testimony of present conditions on well-managed national forests and protected municipal watersheds, from such vestiges of primitive areas as have thus far escaped depletion, and to some extent from geologic evidence. Here may be seen how, during past centuries, soils were safeguarded against excessive erosion and leaching by the binding power of plant roots which filled the surface and subsurface layers and by the physical protection which the plant cover and

organic mulch provided. As rains fell on the area, the full impact was broken by the aerial parts of the vegetation, thereby preventing compacting of the soil surface. On the virgin range dead plants and herbage formed a ground litter, and eventually mixed year after year with the mineral soil and produced a loose, porous earth mantle which absorbed and retained against evaporation the maximum quantity of water from rain and melting snow. The channels formed by plant roots facilitated percolation. As the surface water ran off its velocity was reduced by plant and litter obstructions which checked and broke up the flow. Forest and shrub litter prevented direct access to the soil by water flowing off slopes, and a similar effect though not so complete in semiarid areas resulted from litter of herbaceous plants, hence run-off water was clear or almost so. The water absorbed by the topsoil percolated through the lower soil depths and rock crevices to issue forth later as springs. These maintain the flow of rivers and streams that have made possible irrigation agriculture, electricity for industry, and municipal water supplies.

In that stable and porous soil mantle the young nation pioneering its way into the West had a priceless resource of which it was then and for many decades thereafter unaware. It was a resource built up by the age-old process of soil building and normal erosion, which progresses with the slowness of geologic time, and has throughout millenniums sculptured and molded the face of the earth. The soil of the mountain slopes and the alluvium of the valley floors have been produced in this way—even the rocks of which most mountains are composed have been formed of sediments which are products of older periods of erosion and deposition. The principal method of transportation of the weathered material from the slopes was by natural gravity creep rather than by stripping and gullying by water—the creep of the soil being rarely rapid enough to disturb plant populations or modify their general aspect. Surface run-off carried a minimum of silt, destructive floods were unknown on many areas and uncommon on most others, and streams were generally clear, receiving what silt load they carried from the bottom of channels rather than from the vegetated slopes and protected stream banks.

Ordinarily erosion progressed so slowly that soil was formed or accumulated slightly more rapidly than it was removed. Only under unusual conditions, as in Bryce Canyon, Utah, on certain Mancos shale areas in Colorado and Utah, on the Chinle bad lands of Arizona, and in the Breaks of the Missouri River, have adverse climatic and geologic conditions prevented the fixing of the land surfaces by soil formation and plant growth. In these relatively few instances, run-off has been rapid and normal erosion pronounced, giving rise to muddy streams whose flow fluctuated greatly.

Elsewhere soil and vegetative cover were sustained by virtue of a delicate balance between the constructive and destructive forces. On the one hand the weathering of rock and plant succession built up the soil mantle, and the vegetation that blanketed it served to hold it in place; on the other hand, the destructive forces of a rigorous and variable climate and of steep slopes operated against this accumulation and stabilization. Vegetation was invariably the deciding factor in the balance. The presence of a natural plant cover enabled the constructive forces to hold sway and to preserve watershed values.

The Flood and Erosion Menace of Recent Years

When the white man's herds of cattle and sheep multiplied beyond the capacity of the range to carry them properly, depletion of vegetation upset this natural balance and the utility of the virgin watersheds became impaired. As overgrazing and fire reduced the density of the

FIGURE 65.—CHARACTER AND EXTENT OF EROSION ON WESTERN RANGE LANDS.

As a result of range depletion, accelerated erosion is fast removing incredible quantities of soil from large areas, resulting in the devastation of range and agricultural lands and serious silting of irrigation improvements. In this process, the fertile topsoil on which the range depends in the first to go.

range cover, and as the litter and humus layers were broken through, the devastating forces of soil erosion were greatly accelerated (fig. 65) and unretarded run-off seriously modified the natural stream flow and caused many floods.

Over large areas of the western range the original fertile, sponge-like soil cover has been gashed and stripped off, exposing a sterile, less pervious substratum. Deep gullies and gorgelike channels are common in the valleys and meadows, and slopes have been cut and carved until mere islands of fertile soil remain. Watersheds that formerly yielded only steady, quiet-flowing streams and rivers now produce devastating floods when rains come and a shrunken, inadequate flow at other times. Depletion of plant cover has not only reduced the utility of the unregulated range land but with it has come such a biologic upset to watershed lands that they have become a menace to agricultural, industrial, and social welfare. The full meaning of this threat to the well-being of the entire range country becomes clearer as the havoc wrought is examined in detail.

FLOODS

The flood menace in the West has no static quality. As the effects of depletion are brought into action by abnormalities of storm, floods increase year by year in frequency and intensity. Scarcely a day passes during the period of summer rainstorms that western newspapers of one locality or another do not carry accounts of destruction by water and mud-rock flows. To be sure, such catastrophes are very different from the great inundations that the easterner has learned to expect from protracted heavy rains and melting snow. High water, sometimes reaching flood proportions, is also common in the spring in many western streams. But summer flash floods resulting from a single brief intensified storm or so-called cloudburst may be equally destructive of life and property. A stream course may be dry one minute and the next filled to the brim by a rush of silt- and debris-laden water that within the hour will be utterly gone. Not a drop of rain may have fallen in the valley lowlands upon which such sudden floods debouch. The only warning to the victims may have been the constant threat of plant depletion on watersheds above them—a portent only too seldom revealing its full meaning in advance. Without doubt the flood problem is acute and is becoming of increasingly greater significance in all the range States.

For the past 40 years floods, of a severity to which boulder-strewn fields and valleys bear evidence, have been increasing over the entire length and breadth of Utah. Between Ogden and Salt Lake City 15 canyons in the Wasatch Mountain front have within the past few decades produced such floods—all originating on depleted, privately owned range lands representing a total of only a few hundred acres and but a small portion of each individual watershed. In 1923, and again in 1930, floods and mud-rock flows pouring forth from certain of these canyons exceeded anything which has occurred in that area for at least 20,000 years (*10*). Boulders weighing as much as 200 tons were carried into the valley, farm lands were ruined, homes and other improvements were destroyed, and lives were lost (fig. 66). In 1932 at least 27 important watersheds in the State flooded. An investigation of these areas by State and Federal agencies revealed that this serious situation has developed largely since settlement and that depleted range lands are the chief source of flood waters.

Several drainages in Colorado, tributary to the general area surrounding Denver, are highly susceptible to rapid run-off and periodically produce major floods. From a special examination of the watersheds, made in 1934 it was readily determined that, while the flood menace in this locality was already pronounced, still more serious flooding could be expected if depletion of vegetation continued. There is little doubt that the Pueblo floods of 1921 were due in part to depleted watersheds. They swept the entire Arkansas River Valley from Florence 30 miles west of Pueblo to the State line, causing tremendous waste of property and heavy loss of life.

FIGURE 95.—PROPERTY AND IMPROVEMENTS DEVASTATED BY MUD-ROCK FLOWS.

Sweeping out of the overgrazed watersheds in Davis County, Utah, mud-rock flows, carrying boulders weighing as much as 500 tons, devastated 1,500 acres of the most valuable garden, orchard, and farm land in the State, wrecked homes and farm buildings, and blocked or washed out highways and railroads. Such catastrophes are common in varying degrees of severity throughout the depleted range areas of the West.

Some of the most serious floods resulting from depletion of the plant cover of watersheds have occurred in California, and among these the Tehachapi flood of 1932 stands out as a glaring example of effect of misused range lands. In September 1932 the concentration of water from a heavy rain storm near Tehachapi Pass unleashed its fury on the valley lowlands and caused loss of life and property. The 1934 floods, caused by destruction of vegetation by fire on the watersheds near Los Angeles, attracted Nation-wide attention because of the damage caused. Sacramento Valley experienced a disastrous flood in 1928 as a result of rapid run-off from the exposed slopes of its catchment basins. These are examples of major floods. Other minor floods too numerous to mention, have occurred periodically over much of the interior basin and southern coastal region, building up a staggering total of losses.

In contrast to the spectacular mountain floods oftentimes accompanied by mud-rock flows, are the more common floods of silt-bearing water in the Southwest and Colorado Plateau. In these regions of more gentle gradients and sparsely vegetated slopes, floods have always occurred, but historical evidence together with field investigation clearly indicate that they are yearly becoming more prevalent and more destructive.

In any presentation of the western flood problem it cannot too strongly be stressed that the communities desolated, the individuals bankrupt and bereaved by these floods have in many instances paid in life and property for the privileges enjoyed by themselves or others in the free use of watershed range. The evidence of this is clear. In the Escalante River Valley in southern Utah, for example, the first devastating floods occurred approximately 15 years after the settlers began to crowd the ranges with their herds. Since that time annual floods have been almost the rule, and in the single year of 1932, 19 major floods raged through portions of this valley, inundating agricultural land and tearing away sections of the fertile alluvial valley fill. In 1921, five drainages in western Colorado flooded during a storm that brought only 2.5 inches of precipitation over a 4-day period. The waters from one of the canyons washed out several miles of railroad track and those from another cut a new stream channel directly through the town of Lake City. Run-off from depleted range lands on the tributaries of the Virgin River in southern Utah swelled the river's flow sufficiently during the early spring of 1931 to take out bridges, inundate agricultural lands, and raise the flow of the Colorado River at Boulder Dam higher than had been anticipated for the whole of the Colorado River drainage.

The agricultural lands of the San Juan and Paria River Valleys in Utah have similarly been inundated and eroded, resulting in the abandonment of settlements. Historical evidence shows that the first serious flood came approximately 15 years after settlement, and that from then on catastrophes appeared with increasing frequency.

Further substantiation is given by Olmstead's (*96*) investigations in the Gila River Valley in Arizona where he found a remarkable difference between the destructive floods occurring during the first two decades of the present century and those of the early days. The earlier floods spread out over the countryside with relatively little destruction. The tearing out of great channels and depositing of sterile sands on fertile soil are entirely recent phenomena.

EROSION

ACCELERATED EROSION FOLLOWING RANGE ABUSE

To understand what erosion is doing to western watersheds today, it is essential to have clearly in mind what is meant by accelerated erosion, which followed misuse of land and forage, as distinguished from the normal erosion that has always been in operation. Accelerated erosion is a relatively rapid process, removing from the slopes and even flats soil that was ages in the making. Abnormal in action, it proceeds from man-made rather than natural causes. It is induced chiefly by the destruction of plant cover and the consequent disturbance of the natural balance so necessary to a stabilized soil surface. Accelerated erosion is of several types, the most important

being sheet, gully, and trench erosion caused by water, and another form of sheet erosion caused by wind. Gully and sheet erosion are most pronounced on steep mountainous slopes, trench erosion in the low gradient valleys characteristic of the Southwest, and wind erosion on flat desert or plains country. The seriousness of accelerated erosion is often not recognized until the eroded soil and other debris is deposited destructively on valley floors and along stream channels.

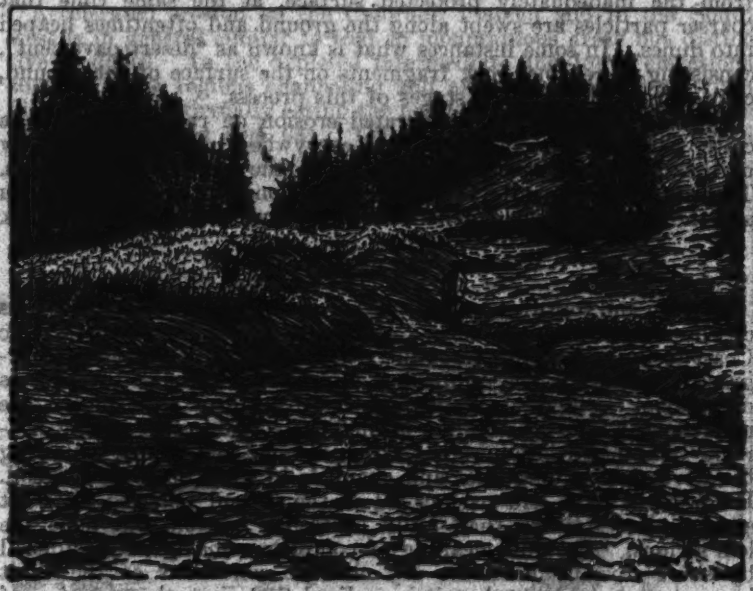

FIGURE 67.—MOUNTAIN SLOPES STRIPPED BARE.

When vegetation that has bound and protected the soil and retarded run-off on the mountain slopes is destroyed, the run-off washes away the soil itself which will require thousands of years to replace. Often a sterile rocky substratum is exposed, as in the above foreground. The vegetated islands of soil that remain as shown in the background of this view, will soon be eroded and gone unless the plant cover on the denuded slopes is restored.

On the mountain slopes, under sheet and gully erosion, soil removal can proceed at a terrific rate. Following the depletion of vegetation, water from heavy rains flows rapidly over the surface, transporting fine soil material with it. By this process a sheet of the fertile top soil has been removed from millions of acres of range land. Where soil texture and topography abet this action, the entire soil cover may be removed (fig. 67). In most situations, gullies also develop early and continue throughout the erosion cycle as the dominant process. In the early phases of gully formation, parallel stringers, often called "shoestring erosion", streak the eroding slopes and form a branched system of deep cuts and washes as they increase in size.

Trench erosion or arroyo cutting is most common in the Colorado Plateau and Southwestern regions, where alluvial-filled valleys are being deeply cut with a labyrinth of vertical-walled channels. Many such trenches, however, have also cut through valleys in Cali-

fornia, Oregon, and elsewhere. Trench erosion arises usually from a break in the surface soils in which the run-off concentrates and channels rapidly through the valley flats. As the initial trench or arroyo advances by headward cutting, tributary trenches develop wherever lateral drainages are intersected and in turn grow into major cuts, each one excavating huge sections of the valley floor.

Wind erosion tears away and lifts in air the finer soil particles from the inadequately protected surface, at the same time that coarser particles are swept along the ground and oftentimes heaped into dunes. In some instances what is known as "desert pavement", consisting of residual rock fragments on the surface of the ground, characterizes the advance stages of this process.

Destruction caused by accelerated erosion on range lands, while costly in social and economic values everywhere, differs considerably in the different physiographic types in the western range areas. These types are, broadly, the mountain regions, the Colorado Plateau and the Southwest, the northern desert valleys, and the Great Plains.

EROSION IN THE MOUNTAIN REGIONS

Erosion and soil wastage present one of their most serious problems on the steeper grazing lands. From the mountains of the Pacific Coast to the eastern slopes of the Rockies, the utility of many overgrazed watersheds has diminished appreciably through the process of erosion. Slopes once comparatively uniform and smooth are marred with sharp niche-like gullies cut to subsoil or sterile bedrock. Mountain meadows have been drained and ruined following the development of gullies and channels in their deep mellow soil. Large areas have had part or all of the topsoil removed by sheet erosion—less striking than gully or trench erosion, but none the less serious. The full meaning of complete removal of the topsoil by sheet erosion under the dry climatic conditions of the West becomes very evident when it is realized that since the recession of ancient Lake Bonneville that occupied basins in the intermountain region 50,000 years ago, only 10 to 14 inches of humic soil has been formed on the most favorable sites of its old beaches and deltas.

What this situation amounts to on mismanaged mountain range in Utah was brought out by a special investigation of a seriously depleted watershed area in Davis County. Here overgrazing and fire had so stripped off the plant cover as to permit 18 to 36 inches of topsoil to be removed on approximately 21 percent of the area; 6 to 18 inches on 22 percent; up to 6 inches on 39 percent; and on only 18 percent of the area was the soil undisturbed. Badly depleted portions are ripped and torn by gullies 3 to 4 feet deep. Stream channels in this area have recently been scoured almost to their heads and in their lower reaches have been cut as much as 70 feet in depth and 200 or more feet wide.

In Idaho and Oregon the slopes of many drainage basins of the Owyhee River are badly eroded and streams which formerly flowed between grassy banks are now seeping along through sandy washes or flowing through raw cuts with steep, sloughing sides. On foothill tributaries of the Snake River in this same general region both sheet and gully erosion are also very evident. In California severe

gully and sheet erosion characterizes a large area of overgrazed land in coast drainage from Ventura County southward, and in the San Joaquin and Sacramento River basins. In other parts of this State erosion is present in varying degrees of seriousness, and is particularly evident on mountain meadows subject to concentrated grazing.

COLORADO PLATEAU AND SOUTHWESTERN REGIONS

Accelerated erosion on the Colorado Plateau and in the Southwest is in general similar to that in mountainous areas but distinctive in detail. In the depleted intermediate and lower elevational zones in these regions channeling and arroyo cutting of alluvium-filled valleys is virtually eating the heart out of the best grazing and agricultural lands (fig. 68). On depleted mesa lands the topsoil

FIGURE 68.—FERTILE VALLEYS DEEPLY TRENCHED.

This view of upper Kanab Creek, Utah, illustrates the channel-cutting resulting from range depletion. Recent erosion has channeled thousands of tons of soil out of the valley floors. Trenches 20 to 100 feet deep and 200 to 800 feet wide are common where, prior to settlement, only shallow streams or drainage depressions existed. In this way, large tracts of fertile and productive land in the Southwest have been ruined.

has been blown or washed away in sheets, leaving accumulations of loose sand, gravel, and rock, or pedestal-like remnants of soil. In the higher elevational zones that have not escaped range deterioration, meadow lands are deeply channeled and drained of their former source of natural subirrigation.

The general acceleration of erosion on the Colorado River drainage basin north of the Grand Canyon was determined by a survey made in 1932 and 1933. Of 115 drainages examined upon which unregulated grazing had been permitted, 111 were eroding at a rate considerably more rapid than normal. In Wyoming and northern Utah raw gullies were frequent and active stream-bed channeling not uncommon. In Colorado and southern Utah the most serious type of erosion was the trenching or channeling of the loose, fertile soil

deposits of the productive valleys, of which Kanab Creek, Johnson Valley, and the Virgin and San Juan Rivers in southern Utah are typical.

Kanab Creek formerly flowed over the floor of a broad, fertile, well-vegetated valley. In the relatively brief period since range livestock were first introduced by the Mormon pioneers, its whole character has changed and it is now confined to a miniature "Grand Canyon" with a channel 30 to 100 feet deep and 200 or more feet wide. Johnson Valley, now called Johnson Wash because of the trenching of the previously aggraded valley floor, is cut with a many-branched arroyo which reaches a depth of 40 feet and a width of more than 300 feet, from which thousands of tons of soil have recently been removed. In the lower valley of the Virgin River heavy silt deposits swept by accelerated erosion from its upper reaches are so clogging the stream flow as to send it meandering over the valley floor, where it is removing additional surface soil and inundating agricultural lands.

In the Southwest abnormal erosion has caused some areas to resemble natural badlands. Portions of the Rio Puerco and Rio Salado Valleys in New Mexico, and the San Simon and San Pedro Valleys in Arizona have been carved with deep channels which divide the valley floor into innumerable isolated segments. In the valley of the Rio Puerco, where only small channels existed prior to 1885, destructive erosion has cut trenches 200 to 500 feet wide in the fertile soil of its floor.

A survey of the upper Rio Grande drainage in New Mexico above Elephant Butte Dam found accelerated erosion within all of nine vegetative types. Within this area only 25 percent of the watershed is in fair to good condition, 35 percent is characterized by advanced erosion, and 40 percent by excessive erosion. The watersheds of the Rio Grande tributaries below Embudo, N. Mex., have a badly depleted cover of range vegetation and discharge enormous quantities of silt and floodwater into the main channel. This silt, carried down and deposited in the low-gradient channel of the Middle Valley, has so built up the channel as to slow down the flow of the river, causing the water-logging of 30,000 acres of formerly productive farm land.

Other studies by the Southwestern Forest and Range Experiment Station, on the Salt River watershed in Arizona, show that an average of 432 cubic feet per acre of topsoil and soil-forming materials is lost annually from typical deteriorated brush ranges.

On mesa areas, such as those on the Navajo Indian Reservation, great sheets of surface soil from the grassland have been blown or washed away as a direct result of grazing abuse, and arroyos 30 to 50 feet wide and 10 to 20 feet deep, with tributary gullies 8 feet wide and 5 feet deep, are common where originally only shallow streambeds and depressions were present.

The higher plateau grazing areas which have been used with no regard to watershed values have been severely channeled. The lower Rio Jemez drainage is a typical example. Here arroyos have been cut through at least 25 percent of the meadows, and 40 to 50 percent more are in the process of cutting.

NORTHERN DESERT VALLEY REGIONS

The erosion picture presented by northern desert valley lands, chiefly of the Great Basin region in Nevada and Utah, is distinctive. In these valleys, although the heavy rainstorms of summer are often of sufficient intensity to cause trouble, the chief erosive agent is wind. Over large areas much of the topsoil has been blown away, and clumps of grass and shrubs, whose roots hold small hummocks of soil together, mark the scattered spots where overgrazing has failed to kill the plant cover. New sand dunes forming in these valleys present a serious threat. One particularly badly overgrazed area near Grantsville, Utah, has been the source of severe dust storms which have blanketed Salt Lake City and Ogden. "Blow-out" holes, 12 feet deep and 4 to 6 acres in extent, have been formed and the surface soil has been stripped or shifted over an area of more than 35,000 acres."

The lowland areas of the Columbia River Basin in Idaho, Oregon, and Washington are suffering also from wind erosion, and sand dunes have formed in many localities. As some of these lands receive more precipitation than do the Utah and Nevada lowlands, they are more generally eroded by water.

GREAT PLAINS

The erosion on range lands of the Great Plains contributes a considerable portion of the great silt load carried by the Missouri, Platte, Arkansas, Red, and other rivers, with their tributaries. Even in the Badlands of Montana and the Dakotas, plant-cover depletion is accelerating erosion greatly beyond its normal rapid rate. Gully erosion is less widespread and less serious, however, than sheet erosion because of soil, topographic, and climatic conditions.

Dust storms, as a manifestation of sheet erosion, have become increasingly more frequent and serious in the Plains region. Thousands of acres of true grazing land from the Dakotas south to Texas, upon which the sod had been broken for agricultural purposes, are the main source of these storms. Areas suffering merely from overgrazing have contributed somewhat toward the dust supply, but their role is overshadowed by the dust resulting from the injudicious attempt to cultivate land unfit for that purpose. Several localities, generally smaller than the famous "dust bowl" of eastern Colorado and western Kansas, are devastated and have in turn ruined many acres of adjacent lands.

The examples of erosion and flood damage specifically cited might be multiplied indefinitely. However, the illustrations presented show that the curse of floods and erosion that has developed over the West in the last half century is a serious and rapidly increasing menace. Floods of accelerating frequency and severity, and slopes and valleys riddled with gullies and chasms bear convincing testimony to man's misuse of the range resources.

" According to unpublished data of the Soil Conservation Service prepared by G. S. Quale and H. J. Hahn in 1938.

Causes of Accelerated Erosion and Floods

That the present serious problem of floods and erosion on the western watersheds is the result of past misuse of range lands is substantiated by extensive evidence of the part played by various contributing factors. Of these the most prominent are the physical factors of climate, soil, and topography and the biological factors of vegetation and organic matter in and on the soil.

Climate

Climate exerts its influence directly on erosion and floods through the amount, kind, and intensity of precipitation and indirectly through its effect on vegetation and soil. Even this direct effect has many ramifications, however, when it is considered that although the West is essentially arid, and some areas in the lower deserts receive as little as 3 to 4 inches of rainfall annually, other areas in the higher mountains receive as much as 60 inches. The kind and intensity of precipitation vary greatly also. At the lower elevations precipitation falls largely as rain, and in many places in storms of sufficiently great intensity to result in rapid accumulations of water having great erosive force. Because of the naturally scant protective cover of vegetation in the arid and semiarid portions, rains relatively light in character as compared to those in more humid areas may run off so readily and develop into such violent floods that they are classed as torrential. In the mountain areas a large proportion of the annual fall comes as snow, which is released as free water only during the spring and early summer. Rains that fall on steep mountain slopes may be intense, greatly increasing the danger of erosion on any soil not bound in place or otherwise inadequately protected by plants; or they may be moderate, causing severe erosion only where plant depletion is most serious and topography steepest.

Hard rains falling on denuded land, whether in the desert regions or in the mountains, result in rapid accumulations of water that inevitably cause the gullying of slopes and trenching of valleys. If there are depleted range areas in the West today on which erosion is only slight or moderate, it is principally because rainfall there is uniformly low in intensity, slope is negligible, or the soil is unusually porous.

The indirect relation of climate to accelerated erosion and floods is exerted through the effect of drought, high temperature, wind, and high rates of evaporation on vegetation and soil. Undoubtedly drought, particularly protracted drought, has contributed greatly to the decline of the watershed value of certain areas by killing off some of the plants or limiting their growth and reducing their density. The death or diminished growth of the plant means, in turn, a general depletion of the plant cover and less physical protection to the soil. During droughts, the physical properties of the soil are modified by excessive drying, its power of cohesion is lessened, and it becomes more susceptible to the forces of wind and water. The stage is thus set for destructive erosion.

High temperatures and winds, causing excessive evaporation, act on the plants and soil in exactly the same manner as drought. Regardless of how much precipitation occurs, it is of no value as a source of water for plants or for stream flow if it evaporates almost as rapidly as it falls. These various forms of the action of climate on the soil and vegetation mantle are serious enough when soil and topography also favor erosion and flooding, but their effects are most pronounced when the plant cover has been depleted by overgrazing and fire.

SOILS

The inherent nature of the soil plays an important role in determining the rate of erosion and the percent of the total precipitation which runs off the surface of any area. Some soils, deficient in plant nutrients, are capable of supporting only a sparse cover of vegetation which influences their absorptive powers but little and affords them a minimum of physical protection against erosion. The relative erosibility of different soils is greatly influenced by such physical properties as their imperviousness to water and their water-holding capacity. The Mancos shales of certain parts of the West, for example, produce soils that are highly impervious, permitting rapid run-off of a large part of the precipitation and a consequent rapid natural erosion. In contrast, soils from the Wasatch conglomerate naturally absorb water readily, permit less run-off, and consequently are not easily eroded. All soils, however, regardless of their inherent nature and the parent rock from which they are derived, absorb precipitation most readily and are subject to a minimum of erosion when they are well clothed with vegetation.

TOPOGRAPHY

Topography of a watershed is a significant factor in determining the extent of erosion and character of run-off. Steepness of slope naturally influences velocity of run-off; and since the transporting power of water increases as the fourth to sixth power of its velocity, it is evident that soil movement would be greater on steeper slopes, other factors being equal. This in turn increases its cutting power. Increased velocity means also that the flowing water passes over the surface more rapidly, thus allowing less time for absorption and penetration. Gravity creep of certain soils on steep slopes, independent of the influence of water, is noticeable in some instances, indicating that the natural balance which is so necessary to soil stability hangs very precariously.

The topographic influence expresses itself also in its modification of the action of general and local climate. Rugged, broken country is less likely to suffer wind erosion than flat or rolling areas where winds can be generated and blow unobstructed with great force. The action of high temperatures and evaporation vary with exposure to the sun's rays, as is evident in the contrast between plant cover and soil mantle on the north and south slopes of canyons and mountains.

Nearly all the effects of topography, however, as in the case of climate or soil, are greatly modified by the plant growth. Under any but extreme conditions of climate, soil, and topography this vegetation mantle is the critical factor of the watershed. Even on slopes steeper than the angle of repose, soils are built up under it. Furthermore, vegetation is the one factor that man can control. Thus the major interest in analyzing the causes of accelerated run-off and erosion centers on the part played by the plant cover.

VEGETATION

On the nonforested arid and semiarid range lands of the West herbaceous and shrubby plants form the vegetation which furnishes protection to the watersheds. Even on forest lands, and especially those open forest types which are suitable for grazing, the herbaceous and shrubby plant growth materially supplements the value of the timber growth and its litter in affording adequate watershed protection. This is especially true in the open orchard-like stands of the piñon-juniper type, where only a small proportion of the soil is directly protected by tree growth. As in forests (*8, 86*), it is not the areal growth alone which is of value. The total plant cover, the root system, the litter, and the humic horizon of the upper layers of the soil composed chiefly of decaying organic matter, all make up the range cover of value in the protection of watersheds. In the main, the vegetation present under virgin conditions represents the type developed by natural forces best adapted to the specific climatic, soil, and other conditions of the particular site.

It has been rather generally recognized for a number of years that the protective cover on range lands has a marked effect in controlling soil erosion and abnormal run-off. Where overgrazing and fire have been rampant, serious consequences were observed; and where some degree of protection has been afforded, favorable watershed conditions have prevailed. Restoration of the plant cover on denuded areas has indicated also its beneficial effect. For example, Manti canyon in Utah (*108*), which was overgrazed badly beginning in the late 70's, produced a number of serious floods between 1888 and 1902. In 1903 this area was included within the Manti National Forest and, after 5 years of complete protection followed by regulated grazing, the range cover has been greatly improved, accelerated erosion halted, and all flooding of any consequence stopped.

The general outcome of the many observations on the relation of range cover to conservation of the watershed resource was, however, one of confusion, as shown by the differences in concepts held by some geologists, engineers, ecologists, and foresters. It became apparent that the role of vegetation had to be ascertained quantitatively by detailed investigation. Research on this subject was accordingly undertaken and, though a vast amount of detailed work still remains to be done, certain general concepts have already been developed and proved.

EFFECT OF DENSITY OF VEGETATION

The first of these investigations (*51*) of any consequence on western range land was instituted by the Forest Service on the Wasatch Plateau, near Ephraim, Utah, in 1912, where a study was made of the run-off and erosion from two grazing areas of about 10 acres each, fairly similar except for the cover of vegetation. Area A had an original plant density of 16 percent and Area B a density of 40 percent. Both areas were grazed and for the 6 years, 1915 to 1920, the cover was maintained at the original densities. During the period 1921 to 1923 Area A was allowed to revegetate until its density approximately equaled that of Area B. From 1924 to 1929 both areas were grazed and maintained at equal densities. The results from summer rains are given in table 55.

TABLE 55.—*The influence of vegetation change on run-off percent and sediment removed during summer precipitation period from two test areas on the Wasatch Plateau*

Values per acre for watershed A			Values per acre for watershed B			A/B ratios	
Plant density [1]	Surface run-off [2]	Sediment	Plant density [1]	Surface run-off [2]	Sediment	Run-off percent [2]	Sediment
Percent	*Percent*	*Cubic feet*	*Percent*	*Percent*	*Cubic feet*	*Ratio*	*Ratio*
16	16.66	109.1	40	2.89	20.7	5.76	5.27
16 to 40	6.74	109.0	40	2.69	17.5	2.93	6.23
40	2.40	19.1	40	1.26	7.7	1.90	2.48

[1] Plant density as here used is the percentage of total soil that is covered by the total spread of the plant's growth.

[2] Percentages are based on effective precipitation.

With area A in a depleted condition the run-off percent and sediment removed were approximately 4.1 and 5.4 times that from area B. As the plant cover was gradually restored on the former, these differences diminished until the ratios for run-off percent and sediment were only 2.9 and 2.8. Finally, when the densities of the plant cover were made comparable, the run-off percent from the two areas was practically the same, and the excess of silt removed from A was reduced from 109.1 to 11.5 cubic feet.

This reduction of silt removed from area A following revegetation has far greater significance than merely the reduction of soil movement, because of its indirect effect on the future rate of absorption and percolation of the soil. This is shown by studies (*86*) conducted by the California Forest and Range Experiment Station, in which slightly less than 2 percent of sediment was introduced into clear water and allowed to percolate through a soil surface. It was found that the rate of percolation of this muddy water amounted to a reduction of 90 percent within 6 hours over the percolation rate for clear water. The sealing of soil pores by sedimentation not only immediately reduced the speed of percolation but this change remained permanent since the subsequent use of clear water did not restore the original percolation rate. This indicates clearly that

silt-laden water from eroding land tends to increase run-off by decreasing absorption on all areas over which it passes.

In southern California, where water is extremely valuable, it is desirable to save as much of the streamflow from mountain canyons as possible. The construction of storage basins is costly and there is a great dearth of suitable sites. A common practice, therefore, is to divert the clear water emerging from such canyons over the gravel beds at their mouths. The water is later pumped from the natural underground storage basins for domestic use and irrigation. If, however, the streamflow is muddy the gravels are quickly sealed by the silt and the water runs off to the ocean, resulting in a scarcity of the underground supply. It is vital, therefore, to prevent erosion of the watersheds which would produce muddy streamflow.

EFFECT OF DIFFERENT STAGES OF DEPLETION

Studies conducted on the Boise River watershed in Idaho, with the aid of a portable apparatus simulating natural rainfall, have demonstrated the value of different plant types in preventing erosion and conserving water on the granitic soils of that region. The effects of varying intensities of rainfall, degree of slope, and disturbance of soil were determined on comparable plots within four plant types ranging from the annual weed, which represents the most depleted type, to the bunchgrass, the most valuable. Under all conditions of the experiment the average percentage of rainfall which ran off and the amount of material eroded for the different types is as shown in figure 69.

The bunchgrass type, which has the greatest forage value of any local range type, and to which most grazing land in this area will ultimately revert if unabused, yielded very little run-off and silt. The downy chess and needlegrass-lupine types, which have succeeded the bunchgrass on overgrazed ranges at the lower and higher elevations, respectively, are distinctly less effective watershed covers. The manner in which these two types contribute to rapid run-off and erosion is shown by the fact that, on the average, 28.5 percent of the precipitation on the downy-chess cover and 47.6 percent on the needlegrass-lupine cover were unabsorbed. Further, as this water ran off it carried the equivalent of 2,017 and 4,783 pounds of soil per acre from the respective types. The annual-weed type affords far less protection than any of the others, permitting a 60.8 percent run-off which transported an equivalent of 15,280 pounds of soil per acre.

The characteristic root systems of the plants in the various types studied, as sketched in figure 69, indicate that for this investigation a dense mat of fine roots near the surface of the soil served best in protecting the soil from accelerated erosion and in obtaining maximum absorption.

The contribution of percent of slope, disturbed soil, and intensity of rainfall to these results is shown in table 56, which is a further

break-down of figure 69. A change in percent of slope was materially noticeable in modifying run-off in the downy chess type only, where excessive loss of water occurred on slopes greater than 30 percent. The unexpected decrease in the run-off from the steeper slope in the needlegrass-lupine type is attributed to the coarser texture of the soil on these slopes. Erosion was accelerated, however, by steeper slopes in every type except the bunchgrass. Disturbed soil as compared to undisturbed gave much the same effect as increased percent of slope. In this case decreased run-off following disturbance of the soil in the needlegrass-lupine type is due to the increase of absorption caused by loosening of the surface. High rainfall intensity accelerated both run-off and erosion from all types except the bunchgrass, which continued to afford suitable protection to the soil even when the intensity of the rainfall was doubled.

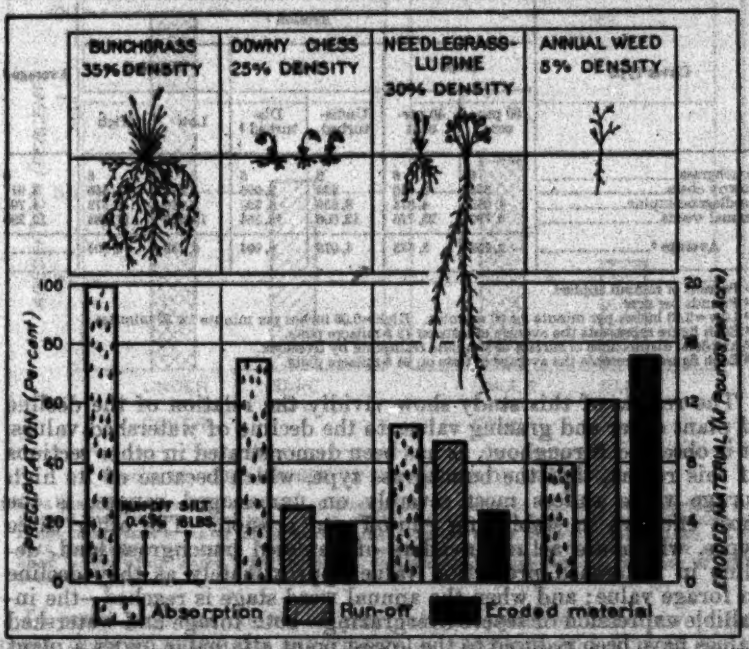

FIGURE 69.—THE MOST DESIRABLE FORAGE PLANTS ARE COMMONLY THE BEST WATERSHED PROTECTORS.

Run-off and erosion from rainfall are negligible where the bunchgrasses predominate—the highly palatable virgin-range cover characteristic of south-central Idaho. Both run-off and erosion are very pronounced where other plants have succeeded bunchgrass because of overgrazing. The greatest percent of run-off and the largest amount of eroded material came from annual weed cover—a plant cover which is an unfailing expression of over utilization. A many-branched, fibrous root system is an important factor in retarding soil removal and aiding absorption.

TABLE 50.—*Run-off and amount of erosion (induced by artificial storms of 1.50 inches on four range types on the Boise River watershed) as influenced by steepness of slope, condition of soil, and rate of rainfall*

Cover type	Run-off[1]						Average[2]
	Slope		Soil		Rainfall[3]		
	30 per cent	40 per cent	Undisturbed	Disturbed[4]	Low	High	
Bunchgrass	0.4	0.8	0.6	0.6	0.4	0.4	0.4
Downy chess	12.3	38.7	22.4	27.6	16.1	34.3	25.2
Needlegrass-lupine	32.0	42.3	36.7	37.1	41.3	32.5	37.0
Annual weeds	36.0	38.6	36.3	38.4	37.3	37.4	37.3
Average[5]	20.0	27.3	23.5	25.9	23.8	26.4	

Cover type	Erosion[6]						Average[2]
	Slope		Soil		Rainfall		
	30 per cent	40 per cent	Undisturbed	Disturbed[4]	Low	High	
Bunchgrass	0	0	0	0	0	0	0
Downy chess	308	3,625	1,966	2,967	775	3,156	2,017
Needlegrass-lupine	4,686	4,971	4,829	4,828	4,885	4,773	4,701
Annual weeds	4,770	20,770	12,770	12,770	13,976	17,564	15,770
Average[5]	2,688	3,073	4,076	4,891	4,139	4,969	

[1] Percent of rainfall applied.
[2] Pounds per acre.
[3] Low=0.25 inches per minute for 60 minutes. High=0.66 inches per minute for 30 minutes.
[4] Each figure represents the average of tests on 12 1-milacre plots.
[5] Artificial disturbance of surface to simulate trampling by livestock.
[6] Each figure represents the average of tests on 24 1-milacre plots.

The results of this study show vividly the relation of the decline of plant cover and grazing values to the decline of watershed values. It is observed throughout, as has been demonstrated in other sections of this report, that the bunchgrass type, which because of its high forage value suffers most severely on unmanaged ranges, is the most effective in stabilizing run-off and erosion. The other three types, which are actual invaders of depleted bunchgrass land, decline in watershed protection value approximately as they decline in forage value; and when the annual weed stage is reached—the infallible expression of severe overgrazing—both forage and watershed values have been reduced to the lowest point attainable under a plant cover.

EFFECT OF RELATION ON ABSORPTION

That vegetation has a definite and very important part in conserving precipitation on watersheds was substantiated by further studies in the same general area. Measurements were taken of the rate of absorption and percolation of surface water on paired plots, each 1 foot square. One of the pair supported a single herbaceous plant and the other was bare soil occurring between plants. Twenty-three pairs were compared for plants typical of well-managed ranges

and 16 pairs for plants common on depleted ranges. The results are shown in figure 70. That plots supporting desirable forage plants absorb water more rapidly than contiguous bare plots or even than plots supporting the less desirable plants, is readily understandable. It is interesting to note, however, that bare soil spots on well-managed range were more absorbent than the bare places on depleted range, owing to the better soil conditions induced by the surrounding vegetation and its wider spreading root systems. Equal quantities of water applied on these plots penetrated approximately 8 inches on vegetated plots on managed range as compared to 3½ inches on vegetated plots on depleted range.

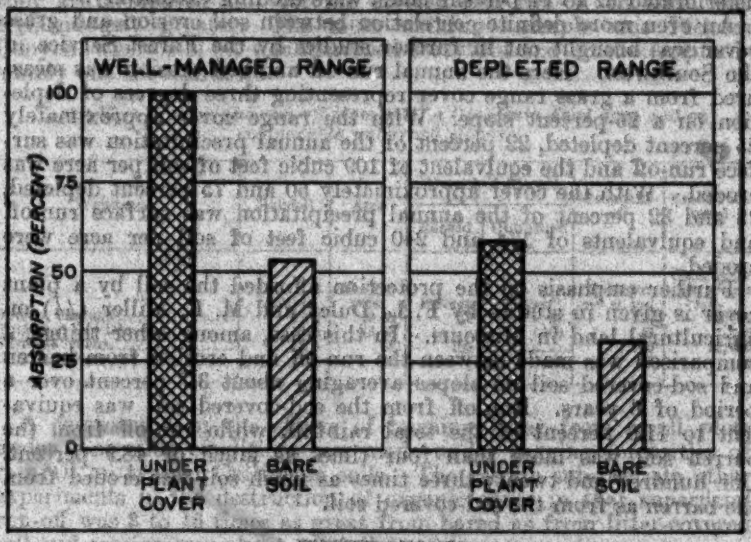

FIGURE 70.—THE EFFECT OF DEPLETION ON ABSORPTION.

Where plants are present, the rate of absorption of water by the soil is materially increased over that on bare soil. It is significant also that bare soil on well-managed range land absorbs water more rapidly than similar spots on overgrazed range. The data shown here are taken from averages obtained on plots on the Boise River watershed. Absorption under plant cover on well-managed range was at the rate of 0.44 inches per hour.

In every case the course of percolation appeared to follow plant roots, demonstrating the superiority of extensive and fibrous roots, characteristic of the perennial plants found on well-managed ranges, over the more poorly developed root systems of plants typical of depleted cover.

The necessity of maintaining an unbroken range cover, as demonstrated on the Boise River watershed, was further substantiated by a general survey of the area made by the Forest Service. This survey brought out the necessity for a plant-cover density of at least 30 percent to avoid erosion, since if grazing depletes the cover below that point, run-off and erosion will be accelerated and the utility of the watershed will be reduced.

SOUTHWESTERN STUDIES CONFIRM RESULTS

A distinct correlation between the extent of range depletion and degree of erosion was revealed in an investigation of range cover and accelerated erosion on the upper Rio Grande watershed by the Southwestern Forest and Range Experiment Station, in which erosion was classified as moderate, advanced, and excessive. It was found that range lands supporting a vegetation cover which had deteriorated 7 to 40 percent in reference to virgin conditions was eroding moderately; lands with a cover depleted 29 to 57 percent were in an advanced state of erosion; and where the cover had deteriorated 52 to 74 percent lands were eroding excessively.

An even more definite correlation between soil erosion and grass cover was brought out in further studies by the Forest Service in the Southwest. Here the annual run-off and soil erosion was measured from a grass range cover representing three degrees of depletion on a 25-percent slope. With the range cover approximately 25 percent depleted, 22 percent of the annual precipitation was surface run-off and the equivalent of 109 cubic feet of soil per acre was eroded. With the cover approximately 50 and 75 percent depleted, 28 and 32 percent of the annual precipitation was surface run-off and equivalents of 174 and 240 cubic feet of soil per acre were eroded.

Further emphasis on the protection afforded the soil by a plant cover is given in studies by F. L. Duley and M. F. Miller (*44*) on agricultural land in Missouri. In this case, among other things, a comparison was made between the run-off and erosion from barren and sod-covered soil on slopes averaging about 3.7 percent over a period of 8 years. Run-off from the sod-covered soil was equivalent to 11.6 percent of the total rainfall, while run-off from the barren soil was more than four times as much or 48.9 percent. One hundred and twenty-three times as much soil was eroded from the barren as from the sod-covered soil.

GEOLOGIC EVIDENCE

Geologic evidence obtained on the Davis County, Utah (*10*) and on certain Colorado River watersheds (*9*) has shown that the devastation of plant cover has been the major cause of accelerated erosion and uncontrolled run-off on these areas. Recent channel cutting and erosion has definitely exceeded any which has taken place for the last 20,000 years in Davis County, illustrating the unprecedented nature of the recent activity, at least in modern geologic times. Since the deterioration of plant cover is the only marked change in the factors effecting erosion and stream flow which occurred since settlement, it is logical to ascribe the activity to that source. On the Colorado River geologic evidence of the influence of plant cover was determined by investigating the gradational process of erosion on natural barren areas in which no acceleration was found. At the same time, on the surrounding localities once stabilized by a plant cover, erosion was accelerating. The deduction was clear that vegetative depletion was the major factor causing the present channeling and gullying on the formerly productive lands in this drainage.

DESTRUCTION OF VEGETATION BY FIRE GIVES COMPARABLE RESULTS

Depletion of vegetation by fire is of interest, since the results in erosion and floods are similar to those from persistent overgrazing. The La Crescenta flood in California is a dramatic illustration. On New Year's Day, 1934, a general rain fell over the southern California foothills including a 5,000 acre area that had been severely burned 2 months previously. As presented in table 57, the records of the California Forest and Range Experiment Station show that the burned Verdugo and Pickens drainages received approximately the same rainfall as the unburned areas to which they are compared and yet the erosion and run-off on them was tremendously greater. The most striking example was Pickens Canyon, where run-off was increased fortyfold and erosion approximately one thousandfold.

TABLE 57.—*Erosion and run-off from the La Crescenta flood area and on comparable unburned slopes*

Watershed	Rainfall	Area	Watershed affected		Peak run-off	Eroded material
			Burned	Unburned		
	Inches	*Square miles*	*Percent*	*Percent*	*Cubic feet per sq. mile*	*Cubic yards per square mile*
Burned Verdugo	12.9	19.06	85	87	930	30,000
Unburned San Dimas	12.6	16.55	———	100	23	30
Burned Pickens	12.5	4.8	100	———	1,920	30,000
Unburned Fern and Bell	12.4	20	———	100	35	30

A comparison of the effects of burning litter from small plots under controlled conditions was made under varying intensities of rainfall on typical California soils. The results substantiate other experiments in the destruction of organic cover in that superficial run-off was 3 to 16 times as great from bared as from litter-covered soil and erosion was about 1,200 times as great.

NET EFFECT ON STREAM FLOW

The results reported above are of great importance on all range lands throughout the West which deliver water for irrigation, power, or domestic use. Most of the usable stream flow comes from the melting of snow and from the gradual delivery from springs and seeps of snow water absorbed by the soil and broken-rock blankets of the watersheds. The more porous the soil cover the more percolation there is and the greater the value of this underground supply. It is the cover of vegetation, its litter, and related values which maintain maximum percolation. With removal of the vegetation the soil pores are quickly sealed and percolation is greatly reduced, as previously explained. Studies on the Wasatch Plateau in Utah have shown that the soil is saturated in the spring from having absorbed its maximum capacity. Spring surface run-off of melting snow was found to be practically unaffected by differences in the vegetation cover. On the experimental areas this spring run-off amounted to about 95 percent of the yearly water delivery by surface run-off.

The stream flow from the melting snow and underground water supply is generally clear, except as it may pick up sediment which had previously accumulated in the stream channel or as it may cut the sides of eroding channels.

On the other hand, in most of the range area summer rains furnish little of the yearly usable stream flow, yet they are the ones which cause most of the destructive floods. The soil eroded from slopes by summer rains is usually deposited in stream channels to clog them and to be carried further downstream by subsequent floods or high-water stages.

Restoration of the range cover on watersheds will result in a material reduction in surface run-off from summer rains and therefore a slight reduction in total yearly surface run-off, but this will be far more than offset by the control of erosion and flash floods with all of the destruction that they imply.

Notwithstanding, attempts are occasionally made to justify such great increases in summer rainfall run-off from depleted areas as have been shown in the studies cited. The theory is advanced that denuded watersheds yield a greater volume of stream flow than watersheds clothed with water-using vegetation, and, therefore, that destruction of the plant cover is no loss. The fallacy in such a theory is apparent when the test of common sense is applied. If true, then the ideal water-yielding watershed would approximate the water-shedding ability of a tin roof. What water fell on its nonabsorbent surface would immediately and completely run off; after the storm had passed, its slopes and gutters would be even drier than the stream beds fed by a denuded mountainside. But there is one great difference—one particular in which the watershed can never attain the ideal "tin-roof" condition. Assume that to overcome the undesirability of loss of rain water from the roof a barrel is placed beneath the eave, just as a storage reservoir may be built in a canyon. One would say that it is only necessary to find a big enough barrel or to build a big enough reservoir to catch and hold all the water that falls. But here the "tin-roof" analogy breaks down, for the tin roof does not erode. How long would the effective life of the barrel be if each storm brought down from the roof great quantities of silt, mud, and debris such as is inevitably produced from a devegetated watershed? The barrel is soon filled and the precious moisture pours over its sides and is lost.

But, argues the theorist, much of this run-off will soak into the soil and be conserved in that way—an argument that overlooks the tests already cited, in which it has been shown how naturally porous and water-absorbing soil surfaces are clogged and rendered impervious by the fine silt washed over them. No experiments have as yet given any indication that the water loss represented by water use, transpiration, and evaporation by and from the plant cover of a mountain slope is at all comparable with the water loss and soil wastage from that same slope devegetated.

The only safe procedure is to maintain as effective a plant cover as possible on all important watersheds. Further research is required to determine the degree to which cover may be modified and still function satisfactorily in retarded run-off, in soil building and binding, in percolation of water, and in other ways to control erosion and stream flow.

OWNERSHIP OR CONTROL OF LAND AS A CONTRIBUTING FACTOR IN ACCELERATING RUN-OFF AND EROSION

Ownership or control of range-land watersheds has been a major factor contributing to their present impaired watershed utility. This relationship is practically identical with that shown in a previous chapter between the status of land tenure and plant depletion. The situation on the five general classes of ownership, based on the best information available from field surveys and published and unpublished records of the Department of Agriculture, is presented in table 58.

TABLE 58.—*The watershed situation on western range lands*

(In thousands of acres)

Ownership class	Principal water-yielding areas[1]	Areas of minor water yield						
		Silting streams[2]		Silting streams[2]		Not silting streams[3]		Total
	Contributing little if any silt	Severely eroded	Materially eroded	Severely eroded	Materially eroded	Severely eroded	Materially eroded	Slight or no erosion	
National forests	61,542	5,527	12,971	2,313	1,131	130	1,220	3,173	27,994
Indian lands	9,913	2,972	5,197	16,130	7,695	2,420	6,646	964	46,924
Public domain, etc.[4]	4,615	6,020	3,960	12,967	20,220	20,225	49,624	5,167	122,228
State, county, municipal	1,167	2,167	2,720	20,201	14,377	2,225	12,240	2,419	77,316
Private	45,217	7,811	12,997	80,118	72,625	80,225	66,114	27,962	373,147
Subtotal		25,497	39,491	171,629	121,049	74,225	134,749		
Total	122,979	28,773		292,197		209,221		67,681	722,673

[1] Range portion of watershed area furnishing 75 percent of water of major streams.
[2] Area contributing an appreciable amount of silt to streams.
[3] Area eroding, more or less, but not contributing appreciably to silting of streams.
[4] Excludes grazing districts, public domain, and other Federal.

Management of the large acreage of privately owned range lands aimed primarily at the maximum utilization of forage has little regard, except in a few notable cases, for sustained production and for the watershed values on which nongrazing interests depend. The production of maximum numbers of steers and lambs is dominant throughout and water yield and erosion control only secondary, if considered at all. The average depletion in grazing value of about 51 percent on private lands indicates, at least in part, why 145 million acres of the private land area is severely eroded and 160 million acres is materially eroded; also why approximately 195 million acres is contributing appreciably to the silting of streams. These conditions indicate the seriousness of the watershed situation on private lands.

Unregulated and highly competitive grazing on public domain, part of which is now being placed under administration as grazing districts, has resulted in practically universal depletion both of the usable forage and the watershed values of these lands. Some other Federal reservations are leased without regard for conservation of the plant cover. Accordingly, there can be little surprise in the fact that approximately 98 percent of these lands as a group is eroding more or less seriously and about 67 million acres are contributing

appreciable quantities of silt to major streams, even though a large part occurs in the Great Basin, which does not drain into major streams.

Unregulated grazing in past years on most Indian lands has had the same effect. The extreme situation on the Navajo Reservation and several smaller reservations on the Rio Grande watershed in the Southwest accounts, in large part, for the high percentage of severely eroding area.

Rental and leasing of most State-owned grazing lands to private individuals have included no administrative supervision of the grazing, and this has meant that no attention whatsoever has been paid the preservation of watershed values, except as dictated by the self-interest of the lessee in preservation of the cover for range use.

Range lands on the national forests, where land use has been under administration with a watershed-protection objective, present a vastly different picture. This is also true of some municipally owned land, representing the water supplies of cities that do not depend on sources within the national forests. In these cases the general land-management policies have been influenced largely by public welfare. The watershed value of grazing land has been recognized and coordinated with grazing and other uses. The result has been that deterioration of the plant cover from overgrazing and fire has been greatly reduced, efforts have been made to restore the cover where depleted, and the yield of usable water and the soil conditions in general are superior to those under any other land tenure. Misused grazing land which has come under the administration of the Forest Service from time to time has for the most part been rehabilitated or started that way, instead of exploited further, with the result that the present range cover on the national forests is on an average depleted no more than 30 percent and only about 6.7 million acres are still eroding severely. These favorable results, no less than the dire results depicted on unmanaged lands, dispel any doubt that the same correlation which exists between ownership and depletion exists also between ownership and destruction of watershed resources, and for the same reason.

The Economic and Social Consequences of Accelerated Run-Off and Erosion

The immediate effects of accelerated run-off and erosion from unmanaged range lands are very serious, but they are only one chapter in the whole story. The economic and social outlook for the entire western United States is being threatened by the consequences of these combined destructive agencies. If this seems too bold an assertion, it is only necessary to turn to other countries and other times to find ample substantiation. Semple (*184*), supported by such other eminent authorities as Sir Napier Shaw and J. Hann, has ascribed the decline and fall of ancient civilizations to misuse of land and the resulting erosion which cut away the productive top soil of hills and fields, leaving in its place barren subsoil or sterile deposits of sand and rock. Homes and lives were, under such circumstances, destroyed by floods, famine followed devastation of agricultural land or loss of irrigation water and improvements, and the inhabitants of established communities were turned into roving

tribes because they could no longer sustain themselves at home. Syria, Palestine, and other Mediterranean countries were the chief sufferers because of climatic and physiographic features. China, as another example, still suffers greatly at irregular but frequent intervals from inundations that take a terrific toll in the great Yellow River Valley and similar areas. The disconcerting history of the water and watershed resources of old-world countries typifies what is now happening on a limited scale in the western United States and what will happen on a far greater scale if the natural resources upon which civilization is fundamentally built are not conserved.

Forage and water produced from the virgin range land were two of the most important resources which enabled the pioneers to build up the present civilization of the West as a monument to the hardships which they endured. The natural vegetation of the range furnished a source of feed upon which a great livestock industry was established. The run-off from the grass-covered hills and mountains contributed much of the water that made the settlement of cities and development of intensive farming and industry possible. Storage and diversion dams, ditches, and canals for irrigation projects were planned and built. Municipal water systems with dams and pipe lines brought water from mountain springs and streams to urban homes. Dams, turbines, and electric transmission lines harnessed water power and conveyed it to where it could be put to its greatest use.

With these industrial and agricultural developments, the population increased rapidly toward stabilization and a general atmosphere of security prevailed. Civilization had come and appeared permanent. But within a short time the first indications of impending disaster appeared in the realization of a few men and organizations that range depletion was occurring and would soon be reflected in reduced carrying capacity, loss of soil fertility, then loss of the soil itself, accompanied by devastating floods and unstable stream flow. These first indications were not particularly striking or evident and it has only been within the last years that general concern has been expressed. The permanency of these industrial and agricultural undertakings, whether it is realized or not, is dependent on the restoration and maintenance of as nearly virgin watershed conditions as possible within the catchment basins. If these virgin conditions can be improved upon, so much the better. For the most part, the point is now no longer argued that widespread deterioration of range lands is resulting in destruction of the soil cover. And the realization is growing that this soil cover has taken geological ages to produce and when once gone cannot be reproduced by any man-made process.

SOIL FERTILITY DESTROYED

Long before the topsoil is completely removed, harmful changes are wrought in its fertility and productivity, especially in the organic content of soil which is so essential to the absorptive and water-holding processes and the nitrogen content which is a prime requisite of plant growth.

The value of nitrogen and organic material in determining the quantity and quality of plant growth produced on a given soil has been amply demonstrated in agricultural practice. Their reapplication to soils already robbed of them by erosion and leaching resulted in a greater than 4-fold average annual increase in vegetation, over a period of 9 years, in recent tests in Utah (*137*). Of vast importance in range-forage production, they are the first elements of the soil to be lost through erosion.

In Idaho, in a survey of the Boise River watershed, soil samples taken from moderately depleted ranges, where erosion was barely under way, contained only 77 percent as much nitrogen and organic matter as soil from the virgin range; and soils from heavily depleted ranges already badly eroded contained only 61 percent as much nitrogen and 55 percent as much organic matter. In Utah, studies showed surface soils from an overgrazed, eroded area contained an average of 31 percent less nitrogen and 38 percent less organic matter than soils from the adjacent protected Salt Lake City watershed. When wheat was grown on both eroded and noneroded soils, but otherwise under exactly the same conditions—5.5 pounds of dry plant material was produced on a unit tract of eroded soil and 12.1 pounds on noneroded soil. Nitrogen and organic matter in surface soil from lightly, moderately, and heavily eroded areas in Davis County, Utah, were on the average 51 and 60 percent, 61 and 70 percent, and 75 and 84 percent deficient, respectively, as compared with noneroded soil.

When the surface soil and its litter and humus layers are partially destroyed, restoration of the range cover through the process of plant succession is exceedingly slow; since each stage in the succession must have increasingly better soil conditions until at last the climax range cover is attained. This slow process of soil building through plant development is, however, not hopeless except in severe cases of gullying and stripping where only geologic time can bring about reclamation. Examples of the slow progress of rehabilitation can be seen on certain areas on the national forests, which were badly eroded at the time the forests were created and even after more than 20 years of protection are still far from regaining the grazing capacity of the virgin range. One of the main reasons for this lag in productivity is deficient soil fertility.

IRRIGATION WATER SUPPLY AND IMPROVEMENTS THREATENED

Agricultural development of the West has been based largely on the cultivation of the semiarid, fertile, and arable lowlands supplied by life-giving streams from the more humid mountain areas (fig. 71). Any modification of rate and quantity of run-off upon which agricultural development is based is reflected in crop production, and as agriculture is built for the most part upon the best possible stream flow from the virgin watershed, the changes which have taken place are inevitably for the worse. If little water from melting snows is absorbed, extremely high peak flows result in the spring, at a season when irrigation is not needed. Indispensable irrigation water is poured out onto the waste lands or into the sea and lost. If the run-off from summer storms rages forth from the canyons as floods, farms

and communities, which by force of circumstances are located in floodable areas, will be devastated.

In other words, irrigated farming is based on usable run-off and if adequate reservoir capacity is not available, requires naturally controlled stream flow to sustain it properly. Natural flow of streams, however, by no means furnishes sufficient water to make all the fertile

FIGURE 71.—PLANT COVER ON MOUNTAIN SLOPES VITAL TO LOWLAND AGRICULTURE AND INDUSTRY

Lowland valleys such as shown in the aerial view of a section of Davis County, Utah, rely on mountain and uplands for irrigation and domestic water from the more humid, snow-covered watersheds. To obtain this supply of water and at the same time avert the danger of floods, adequate plant cover of the watersheds must be maintained. Where vegetation is destroyed, as on the mountainsides in the foreground, the water runs off quickly and gullies have begun to form. Soils and mud-rock flow will wreck irrigation systems in the agricultural lands below. That undisturbed plant cover will furnish the desired protection is proved by the fact that no floods have come from the canyon at the right, where the cover has been maintained.

desert land blossom into productivity. Frequent water shortages occur in all Western States. Efforts are being made to overcome these shortages as rapidly as possible by building storage facilities where suitable reservoir sites are available to catch and hold surplus stream flow when it is not needed and release it when the parching fields require more than would otherwise be provided. The very considerable regulation of stream flow brought about by these improvements has been the means of stimulating agricultural development in many sections where it would have been impossible otherwise. Diver-

sion ditches and canals to conduct the water from rivers and streams help complete the reclamation undertaken.

These irrigation structures of one kind or another in the range-land States made possible the production of crops valued at nearly $4000,000,000 (*769*) in the single year of 1929. The maintenance of the tremendous investment (table 59) in these works at maximum efficiency is a paramount consideration. A greater share of the stream flow upon which the irrigation depends is from the high mountain areas (fig. 72), many of which have been under national-forest administration for 30 years, thus insuring a measure of protection to the natural stream flow. The resources of the intermediate and lower and in some localities the higher elevational zones, however, have not been under administration. These have suffered much depletion of their plant cover from overgrazing and fire. As a consequence both the permanent and intermittent streams issuing from them are silt laden.

TABLE 59.—*Acreage of irrigated land, together with value of land, buildings, and machinery, and the value of irrigation improvements for irrigated farms in Western range-land States*[1]

State	Irrigated area	Value of land, buildings, and machinery	Value of reservoirs and distribution systems
	Acres	*Dollars*	*Dollars*
1. Arizona	575, 000	127, 200, 710	75, 235, 197
2. California	4, 740, 052	2, 265, 075, 510	430, 967, 979
3. Colorado	3, 248, 619	614, 120, 010	57, 091, 240
4. Idaho	2, 151, 209	356, 485, 084	84, 895, 244
5. Kansas	71, 200	13, 685, 000	1, 825, 667
6. Montana	1, 895, 213	305, 027, 613	50, 219, 204
7. Nebraska	823, 617	91, 775, 783	21, 295, 210
8. Nevada	456, 640	69, 895, 681	15, 457, 921
9. New Mexico	827, 088	99, 120, 405	18, 594, 389
10. North Dakota	4, 000	1, 462, 000	1, 207, 214
11. Oklahoma	1, 670	1, 771, 000	180, 000
12. Oregon	898, 713	171, 618, 021	39, 734, 648
13. South Dakota	47, 107	11, 776, 750	4, 522, 117
14. Texas	706, 017	198, 143, 300	48, 022, 164
15. Utah	1, 226, 156	312, 262, 240	56, 695, 510
16. Washington	498, 228	106, 725, 037	40, 561, 289
17. Wyoming	1, 294, 168	236, 002, 003	28, 135, 187
Total	19, 944, 899	4, 817, 706, 073	1, 010, 174, 309

[1] From Fifteenth Census (*69*).

CRITICAL CONDITIONS IN THE SOUTHWEST

At the present time a most critical situation from the irrigation and maintenance of irrigation improvement standpoints exists in the Southwest. This is true for three broad reasons: First, because such large portions of the southwestern watersheds are in the zones which have been badly depleted by unrestricted grazing; second, because the prevailing soil types are very susceptible to erosion; and third, because so many storage dams and diversion works are needed, creating an immense capital investment in the irrigation enterprise. Two of the most active expressions of the situation are seen in the devastating floods which occur and the growth of silt deposits in reservoirs and other irrigation works.

In this region small floods frequently wipe out individual farms and homes, and larger floods that inundate and spread destruction over entire communities are comparatively frequent. The irrigation

district in the Palo Verde Valley (*148*) on the Colorado River in California is often menaced by floods, a single one in 1922 causing damage estimated at $1,000,000. To combat the flood threat this district had, up to 1931, spent $2,400,000 on flood-protection work. The

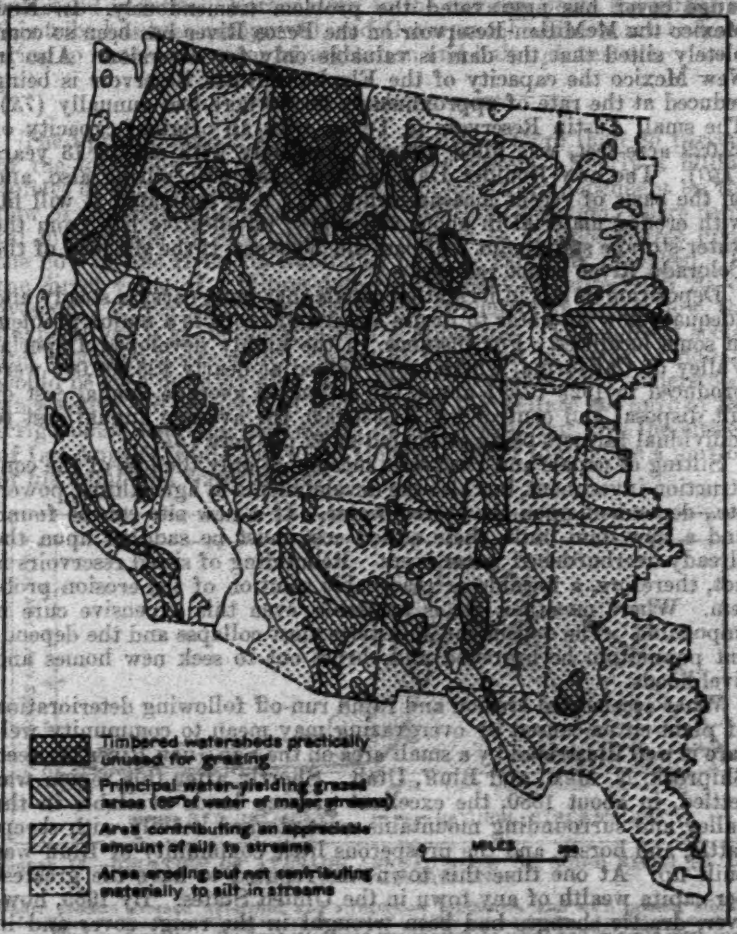
Timbered watersheds practically unused for grazing
Principal water-yielding grazed areas (65% of water of major streams)
Area contributing an appreciable amount of silt to streams
Area eroding but not contributing materially to silt in streams
MILES

FIGURE 72.—IMPORTANT WATER-YIELDING AND SILT-PRODUCING AREAS.

Of the area yielding 65 percent of the flow of major streams, approximately 250,000,000 acres is grazed, 60,000,000 acres of which is contributing an appreciable amount of silt to streams. An additional 202,000,000 acres of range lands are also contributing appreciable quantities of silt to major streams. This means that the watershed utility is being impaired and that river beds, storage reservoirs, ditches, and canals are filling and clogging until their efficiency is seriously threatened.

lower Rio Grande Valley (*151*) in Texas and Mexico suffers also from floods at more or less frequent intervals. One occurring in 1932 practically wiped out flood-protection improvements costing approximately $5,000,000 and caused damage to other property estimated at $1,000,000 on the American side of the river alone.

The life of several storage reservoirs in the Southwest is being threatened by silt deposits which result from accelerated erosion in their catchment basins. Such rivers as the Colorado normally transported considerable silt in suspension, but denudation of the virgin range cover has aggravated the problem tremendously. In New Mexico the McMillan Reservoir on the Pecos River has been so completely silted that the dam is valuable only for diversion. Also in New Mexico the capacity of the Elephant Butte Reservoir is being reduced at the rate of approximately 20,000 acre-feet annually (*75*). The small Austin Reservoir in Texas, with an original capacity of 32,029 acre-feet, was filled almost completely with silt in 13 years (*140*). The new Boulder Dam is threatened with silting also, and on the basis of recent measurements (*54*) it is estimated it will fill with eroded material in about 220 years; its effective life from the water-storage standpoint will pass much sooner, if the silt load of the Colorado River is not reduced.

Deposition of silt in irrigation canals that must carry a steady and adequate flow of water to insure success of crops is a major problem in some localities. For instance, in the highly developed Imperial Valley of California, where crops valued at nearly $25,000,000 were produced in 1929 (*159*) alone, the estimated average annual cost of silt disposal and control was $1,230,000, the average annual cost to individual farmers being estimated at $2 per acre (*54*).

Silting of canals and reservoirs means not only the loss of the construction investment, but also the developments in agriculture, power, etc., dependent upon the stored water. If a new site can be found and a new dam built, their added cost must be saddled upon the already overburdened water users. Rebuilding of silted reservoirs is not, therefore, a feasible or reasonable solution of the erosion problem. Where no other site is available, even this expensive cure is impossible. The dependent industries must collapse and the dependent population be uprooted and thrust out to seek new homes and livelihoods.

What accelerated erosion and rapid run-off following deterioration of plant cover caused by overgrazing may mean to community welfare is well illustrated by a small area on the San Juan River between Shiprock, N. Mex., and Bluff, Utah. Shortly after this region was settled, in about 1880, the excellent grazing lands available in the valley and surrounding mountains were stocked heavily with sheep, cattle, and horses, and the prosperous little community of Bluff was built up. At one time this town was reputed to have the greatest per-capita wealth of any town in the United States. By 1935, however, drastic changes had been wrought in the range cover and in the dependent community. The density of range vegetation had decreased from an average of 52 percent to less than 4 percent; one-half of the agricultural lands had been eroded away; damage from floods and erosion estimated at approximately $750,000 had been caused; 10 lives had been taken by flood waters; property was tax-delinquent; and the village population had declined from 600 to 50 people. This community literally signed its own death warrant by disregarding the consequences of range destruction.

The great gullies and sterile plains now in evidence on the Navajo Indian Reservation (*182*) are further indications of the ravages of

water on depleted range lands in the Southwest. The very existence of these Indians, scanty as it is, is threatened by accelerated and unrestrained erosion. Water holes are drying up and floods are common. Against the processes of erosion of his own making, the red man's last stand is futile. Fortunately, in the last few years the plight of this tribe has been recognized, and Government agencies are endeavoring to restore the cover of vegetation and halt soil wastage.

THE COST OF WASTE WATER

The upper Colorado River Basin furnishes more than 85 percent of the total flow of the Colorado River system. Nearly a billion dollars of existing and potential developments are dependent on the flow of this river and its tributaries. Without question, where capital investments of such magnitude depend to a large degree upon the flow of one river, its watershed must be carefully managed. If the direct value of a billion-dollar investment is depreciated 20, or even only 10, percent by avoidable lack of control of stream flow, the financial loss is as inexcusable as it is appalling. The indirect social and economic losses which cannot be measured in terms of dollars would be even more striking, however, if they were fully understood, since active soil erosion and floods attack the welfare not only of the irrigationist near the headwaters of the stream, but also the citizen of Los Angeles, who looks to the Colorado River to produce a portion of his municipal water supply.

FIGURE 73.—RELATION OF AVERAGE ANNUAL FLOW OF BOISE RIVER TO ACTUAL WATER REQUIREMENTS.

Under present average watershed and stream-flow conditions, and with normal storage facilities on the Boise River, water is wasted (on the average) after April 1, when these are filled to capacity. By June 24 stored water must be used, and this can keep until August 22, after which a shortage occurs which results in an average annual loss in crop income estimated at $1,614,000. Additional storage is economically impracticable. If spring run-off were to be delayed by careful management of the watershed cover, loss of the peak flow would be reduced and stored water would be available in the late season for maturing crops.

Where the demand for usable irrigation water far exceeds the supply, as, for example, in southern Idaho, the need for careful management of watershed resources can be vividly illustrated. Under such circumstances it is absolutely necessary that streams produce a maximum flow in the most usable form. Figure 73 pictures normal flow, the average actual flow as developed from stored water, and the average annual water shortage which arises on the Boise River. The

average annual waste of water down this river, owing to lack of sufficient storage facilities, is approximately 448,000 acre-feet. On June 24, on the average, the natural flow of the river drops below requirements, and it is necessary to supply the deficiency from stored water. The reservoirs which thus supplement the flow are drained, on the average, by August 22. To provide for maximum-crop production, however, water should be available through September in a quantity of 272,632 acre-feet over and above the average flow during this late-summer and early-autumn period.

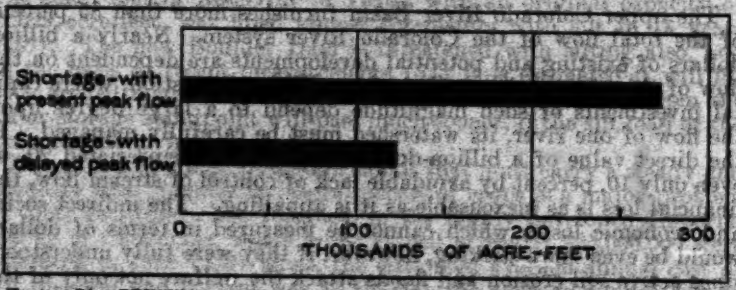

FIGURE 74.—PRESENT AVERAGE ACTUAL WATER SHORTAGE, CONTRASTED WITH SHORTAGE IF PEAK FLOW COULD BE DELAYED 10 DAYS.

If it were possible to so manage the plant cover of watershed lands as to delay peak flow of the Boise River 10 days—and indications are that some such delay might be accomplished—the average annual shortage of water could be reduced 63 percent, making additional water available at the season when it is badly needed.

Obviously two courses appear to be open to correct this situation—more storage or delayed spring run-off. Surveys have indicated that additional storage facilities are economically unpractical. Accordingly, delayed spring run-off appears to be the only feasible approach; and while it cannot be definitely stated that intensive management will consummate this purpose on this already comparatively well-handled watershed, studies of absorption, penetration, and retarded run-off made thus far indicate that at least a more satisfactory situation may be approached by properly controlling the cover of vegetation, particularly that of the herbaceous and shrubby plants. A 10-day delay in the peak flow, which would bring it approximately at the peak of requirements, would result in an average annual shortage of only 123,000 acre-feet of water, instead of the actual shortage of some 278,000 acre-feet (fig. 74). This average increase in available water, coming at a season when irrigation is so urgently needed, would mean a material decrease in the $1,914,800 average annual loss in gross income that water shortage now causes. The general theory of this discussion pertains to many watersheds of the West, of which the Boise River is only one example upon which data are available.

The proper management of the range cover to delay run-off from a specific watershed is not confined within the boundaries of the watershed itself. Lowland areas of depleted plant cover entirely outside the watershed may influence materially the yield of usable water from a mountain watershed by contributing to early spring dust storms. At the time that most serious dust storms originate, the most important western watersheds are covered with a winter's

accumulation of snow which should melt slowly to insure properly regulated stream flow. However, when dust from depleted lowland areas is deposited in the mountains, the snow cover melts perceptibly faster. The dust cover on the snow absorbs heat from the sun rays to a far greater degree than the snow surface itself. The effect is that of placing a warm blanket over the snow surface, and more rapid run-off is the outcome. During the spring of 1934 this general phenomenon was observed throughout the intermountain region. It forcibly illustrated the conclusion that watershed protection is not confined to watershed boundaries but is a regional problem.

COSTLY FLOODS

The importance of watershed resources is probably recognized more fully in California and Utah than elsewhere in the West, largely as the result of a series of catastrophes. In California the floods in and around Los Angeles have brought home the realization that many other communities have thus far missed—that denudation of a watershed, regardless of cause, is a serious menace to life and property. In the previously mentioned La Crescenta flood 30 lives were lost, 488 homes destroyed, and a total damage caused that was estimated at $5,000,000. At present in this same locality 380,000 persons and property valued at $300,000,000 are still directly subject to the ravages of floods if the local watersheds are devegetated (*46*).

In Utah, devastating floods and mud-rock flows issuing from misused watersheds along the Wasatch Mountain front have made the entire State conscious of the consequences of range depletion. During a 10-year period prior to 1934 damages conservatively estimated at slightly more than $1,000,000 have been caused by such floods in the small, intensively farmed section between Ogden and Salt Lake City. The communities Centerville and Bountiful, adjacent to where these floods occurred, recognized the value of a protected watershed some years ago and gained control from private owners of the area directly influencing them. Under their protective administration the plant cover has been maintained, no floods have been experienced, and a healthy feeling of security foreign to their less farsighted neighbors is well established.

These examples might be multiplied many times over. As previously discussed, the flood situation is not limited to one locality. Costly floods, in both life and property, occur every year in nearly all parts of the range country as a consequence of depletion of the protective vegetation.

MUNICIPAL WATERSHEDS

The necessity for the protection of watersheds furnishing water for municipal use has been recognized almost universally where the source of supply is relatively near to the point of consumption. As a rule, the watersheds yielding water for cities of any size, such as Salt Lake City and Denver, are either under municipal regulation or are included in the national forests. The role of vegetation is recognized, and strict supervision of all activities on the watersheds is enforced.

Cities drawing water from rivers and streams whose headwaters are remote to them should be actively interested in seeing to it that their watersheds are under the jurisdiction of a public agency interested in watershed protection. Civic growth and development are limited by the amount of usable water available. It should be realized that the building of a new factory or the exploitation of a new subdivision may depend upon whether or not accelerated and uncontrolled run-off and erosion are occurring on a watershed some few hundred miles distant. For example, Los Angeles is vitally concerned with the life of the Boulder Dam and the acceleration of erosion and run-off on the Colorado River above it.

WATER POWER DEPENDS ON CONTINUOUS STREAM FLOW

Municipalities and industrial enterprises should be concerned with the eventualities which face their supply of electricity generated by water power. The water power resources of the West are one of its greatest heritages, and it is not intimated that power shortages could arise, providing capital is available for their development. But uncontrolled run-off and silting of dams may not only jeopardize undepreciated investments but actually limit industrial and domestic expansion because of the excessive costs of producing power on new sites in more remote localities.

RECREATION AND WILDLIFE RESOURCES IMPERILED

To the millions of sportsmen, recreationists, and wildlife conservationists through the entire United States, the effect of accelerated, heavily silt-laden run-off on the fish resources and recreational value of mountain streams is of vital interest. Many recreationists have returned to what they remembered as a permanent camping and fishing paradise, only to find camp grounds eroded away, stream banks freshly cut and denuded of vegetation, favorite fishing holes filled with silt, moss-covered rocks of the stream-bed scoured clean by silt and gravel, and fish that once tested their skill, gone. Gone not because they had been hooked, but because the disturbance of their native habitat and food supply had made existence impossible, or because they had been washed from their holes and sheltered havens by floods and mud flows. Game and fighting fish demand fairly natural or virgin conditions of habitat and channeled and scoured streambeds will inevitably cause migration or death.

The consequences of accelerated erosion on streams in and upon which the fish and campgrounds are destroyed are broad. The rural community or business enterprise suffers a declining tourist trade, a source of income upon which more and more persons have lately come to depend; and the recreationist, who is rapidly becoming more prominent both in numbers and in his dependence on outdoor enjoyments is deprived of diversions essential to peace of mind, health, and happiness.

"BLACK BLIZZARDS" OF THE PLAINS SPREAD DESTRUCTION

Dust storms caused by the action of wind on denuded soil surfaces have already been mentioned. They have produced serious

consequences during the past few years. Beginning in 1932, and again in 1934 and 1935, great clouds of dust have rolled eastward from the Great Plains owing to a combination of drought, wind, and devegetation which resulted from the attempt to cultivate true grazing land. Abandoned farms now stand as ghostly evidence to man's lack of regard for nature's balance and the vicissitudes of climate. The physical and mental suffering involved have been appalling. Homes have been deserted and a despondent yet virile farm population thrust out to experience the hardships of seeking new homes in a country lacking more unappropriated arable land. In general, the dust storms of the past and the potential hazards of future ones have made a considerable section of the Great Plains a less desirable place in which to live for both the urban and rural dweller. Business enterprises are insecure, farming hazardous and personal health endangered.

Dust storms have arisen also from the range lands in the Great Basin, Columbia River Plateau, and southwestern regions, and although the local area affected has been much smaller, their consequences are similar to the storms originating in the Great Plains.

CONTRASTING WATERSHED AND GRAZING VALUES

Although grazing is often considered the outstanding value of range lands, watershed protection may be of even greater importance on over half of the total range area. The grazing value of these watershed lands seldom exceeds $3 per acre and is often less in their present denuded condition. The actual value for watershed protection has never definitely been measured. Investments of over 5.8 billion dollars in irrigated land and improvements compare with about 4.1 billion invested in range livestock and private range lands and facilities used in their production. Of the 475 million acres of range land making up either the important water-yielding or silt-contributing areas of major stream basins every acre supports an average investment of $12.27 in irrigation works, irrigated land, and facilities. In addition these areas support millions of dollars invested in power facilities which furnish electric light and power for cities and industry; a large part are on drainage areas which supply water to thousands of communities.

The Boise River watershed in Idaho supports a dependent agricultural investment in the valley of about 53 million dollars equal to $32 for every watershed acre. The watershed of the Roosevelt Reservoir, the storage basin of the Salt River project in Arizona, supports an investment of $67 and a yearly production value, as of 1928, in agricultural crops and power of $9 for every watershed acre.

Silt accumulations in many important reservoirs of the West, primarily the result of accelerated erosion caused by range depletion, are threatening the permanency of the communities which such improvements have made possible. In the relatively short period of 17 years, 12 percent of the capacity of the Elephant Butte Reservoir in New Mexico, for example, has been completely silted. The Rio Grande channel, near Albuquerque, has become so choked that it will cost over 10 million dollars to provide flood protection and drainage works. These examples could be supplemented by many more, some of which have already been given.

The extreme flood hazard of the West, under present conditions of impaired watersheds, results annually in unjustified loss of life and millions of dollars in property damage. The floods from depleted watersheds of Davis County, Utah, wrought havoc in the valley communities equivalent to $75 per acre for the entire watershed; if this damage were prorated only on the denuded areas from which the flood waters came, the losses would aggregate $1,245 per watershed acre. Had protective cover been there such damage would not have resulted. High values have also been placed upon the steep mountain brush-covered watershed lands of Los Angeles County, Calif., where the value of services in water delivery and flood protection have been estimated at $300 per acre. Such destruction as emanated in the La Crescenta flood on New Year's Day, 1934, from an extremely small burned watershed area, clearly indicates the great importance of maintaining the protective value of the vegetation on these steep mountain watersheds unimpaired.

Protection of these critical irrigation and other community values, dependent on effective watershed maintenance, means more to the West as a whole than the ranches and livestock dependent on the watersheds for grazing or the value of the forage which these watersheds produce. If it should become necessary to choose between exclusion of livestock for watershed protection and continuation of grazing, unquestionably the only practical course would be to eliminate grazing. However, if proper coordination of grazing and watershed protection were provided, elimination of grazing from watershed lands, except on relatively small areas, would not be necessary. Many of the irrigated ranches owe their economic soundness to the fact that range forage produced on the watershed lands can be utilized by livestock fed part of the year on the ranch. The outlying communities on these watershed lands also serve a useful economic and social purpose. Continued grazing of these watersheds under proper regulation is therefore desirable. Responsibility for maintaining favorable watershed conditions on the several hundred million acres of range lands, insofar as grazing use is concerned, accordingly rests both with the livestock industry and the public.

The Way Out—Restoration

Fortunately the destruction of the watershed resources of the virgin range has not as a whole proceeded to the point where the situation is hopeless. Certain bright spots are still scattered over the entire West, and with these and the policies which have been applied to them as a nucleus, a way out of the present dilemma is indicated.

Municipal watersheds which have been protected, certain privately owned lands upon which productivity has been maintained, and national forests which have been managed with watershed conservation as a major consideration, make up the favorable side of the present picture. For the most part accelerated erosion and floods offer no problem on these areas because of the suitable plant cover which has been sustained or restored on them since they came under their present ownership or control. On the national forests, as an illustration, one of the most important responsibilities associated with the administration of range lands has been their protection and management as watersheds. This duty has been recognized since

the creation of the forests, and fortunately for the sustained development of the West, many important water-yielding areas are included within their boundaries. At the time the Forest Service undertook administration of the national forests, the cover on many watersheds had been so severely depleted that erosion was rampant and floods were common. Now, under a system of land management that has watershed conservation as a basic principle, most of these eroding areas have been improved and many have been rehabilitated completely.

Reference has already been made to the Manti National Forest in Utah, where it has been said that at one time the number of bands of sheep could be counted by the dust clouds which they raised. Inevitably, these depleted ranges became eroded severely and floods occurred. The settlement at Manti and others situated on the valley floor experienced their first floods in 1888 after more than 30 years of security. These first floods were followed by others more devastating, until the effects of reduced stocking and regulated grazing following the creation of the national forests began to be reflected in a restored plant cover. Thus through protection and rehabilitation erosion was halted, run-off was regulated as satisfactorily as possible under natural conditions, and floods, since 1910, have been unknown.

The history of Forest Service administration of grazing land is replete with such examples. Owing to the very badly depleted condition of the ranges prior to the creation of the forests and the economic demands upon the ranges since that time, erosion has not been halted completely in every case, but enough has been done to make it evident that control by vegetation is possible and feasible except where erosion is extreme.

Although climate with its vicissitudes of drought, torrential storms, and excessive precipitation; topography with varying degrees of slope; and soils with contrasting susceptibility to erosion, are important factors in the stability of the watershed resources, the plant cover of the range has been shown by conclusive research to be the key to the situation and it is the only one that man can manipulate. Unwise use and lack of management on a large share of the range lands have brought about the present state of depletion and devastation and this misfortune must be corrected and improved. Rehabilitation and continued maintenance of a plant cover is the method whereby erosion scars can be healed, silt load of streams reduced, and unregulated and flood-producing run-off controlled in a manner that will yield the maximum quantity of usable water.

The western United States stands today at the crossroads and must choose between controlled management of its vast area of unregulated grazing land or continued exploitation and eventual devastation. The latter course leads to a China or Syria, with accessible range and forest land almost totally devastated and inundating floods of common occurrence. The other leads to conditions similar to those in many nations of Central Europe, where efficient land management policies are practiced to conserve and protect the watersheds. Without doubt the efficacy and desirability of the road to proper and conservative management has been demonstrated by the history and present status of these contrasting nations. Cannot America profit by this experience?

AS A HOME FOR WILDLIFE

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The Wildlife Problem

Within the limitations set by the needs of civilization for lands and waters formerly supporting game and fish, the two problems of coordinate importance in wildlife conservation are to work toward the opportunity for hunting and fishing characteristics of earlier days, and to rebuild the formerly abundant opportunities for esthetic enjoyment of wildlife. The solution of the first problem reduced to terms of practical achievement has three important phases: First, to restore total population of game birds, game and fur-bearing animals, and game fish to a level that will make hunting, fishing, and trapping more generally available than they are now; second, to accomplish the widest possible geographic distribution of this population—that is, ready availability to hunters and fishermen; third, to increase largely the total area on which hunting and fishing at a nominal charge or no charge for the privilege will give opportunity to the multitudes who cannot afford the luxury of costly field sport.

Solution of the second problem, perpetuation of nongame species and the making available of game species for esthetic enjoyment and observation, on the whole is less difficult and requires less ingenuity than the task of bringing back takable game and fish.

The range lands make up well over one-third of the total area of the country; and are the least complicated by permanent human occupancy of any considerable area. Potentially, therefore, they represent a major opportunity to develop fish and game populations. To understand what these possibilities are, the nature of the biological background for wildlife production and management must be sketched.

Wildlife a Product of Environment

Wildlife is a product of land and environment, just as are trees, shrubs, or grass. That animal species possess varying degrees of mobility at times obscures but does not alter this fact.

The essential requirements of feed, water, and shelter vary for each species, and are, to a high degree, specific characters determining the range—i. e., the environment—which a species finds suitable. Large groups of both animals and birds, for example, are meat eaters; others are herb eaters; some groups require heavy cover, while others are dwellers in the open. Popular, and to some extent scientific, classification recognizes these inherent characteristics.

The relative inflexibility of the demands of many species for habitats with certain combinations of climate, cover, and water is illustrated by the large number of species found only within indi-

vidual areas of uniform environment. The species that are so biologically adaptable as to succeed in a wide diversity of environment are in the minority.

The adaptation to, and dependence upon, particular total environments has been found, for many species, to tie to key factors. For example, some woodpecker species will nest only in dead trees, and a forest without snags is for them an unacceptable environment.

Thus the process of organic evolution through which each species developed a certain combination of requirements, narrowly or broadly limited as the case might be, results in a total wildlife population in natural balance within itself and with its environment. Within a given habitat the struggle for existence between strong and weak individuals of a species, and between species, produces such a pattern and wealth of wildlife as the early explorers found in the western range country.

When white men first pushed their way into the western range they found a land rich in natural resources. Early accounts of exploration and settlement repeatedly mention the abundant forage and wildlife; for example, in writing of his journey across the Plains in the summer of 1858, Hayden (*71*) found the prairies clothed with luxuriant growth of grass and literally alive, as far as the eye could reach, with vast herds of grazing buffalo. Reports of first settlement in California tell of countless thousands of deer, elk, antelope, and quail seen in the foothills and valleys, and of the myriads of waterfowl in the lakes and marshes.

In Montana, so the journal of the Lewis and Clark expedition of 1804 to 1806 (*37, v. 1*) records, the valleys of the upper Missouri and Yellowstone supported an aggregation of game animals that for number and variety exceeded anything elsewhere that the eye of man has ever looked upon. The story of the Northwest is one of abundant wildlife, particularly of beaver and other fur bearers, of fur brigands competing in the wilderness for the largest catch of furs, and of an enormous fur trade. In the Southwest an abundance of antelope over large areas was particularly noted; and in the Rocky Mountain region there was an equal abundance of deer, antelope, wild chickens, and fish. Only in parts of Nevada and Utah, the heavily timbered country of Idaho, and extreme western Montana was a scarcity of game recorded.

It is natural that the early accounts should emphasize the game species, both of land animals and fish, for the food and lives of the early explorers often depended on them. In nongame country, such as that encountered by Lewis and Clark in the Selway River country of Idaho, explorers were forced to eat their dogs to live. But later expeditions, scientific in character, found that the nongame species of this relatively undisturbed environment were actually numerous.

How Reduction in Range Area and Its Depletion Reduced Wildlife

Range depletion, following the rapid occupation of the range country and its violent subjugation to man's use, signified, in its effect on wildlife, not merely reduction in the total quantity of for-

age available, but also practical elimination of many plant species valuable for grazing animals, invasion by worthless species, starting of widespread erosion, destruction of springs and streams, reduction of soil fertility and destruction of essential cover. This is equivalent to saying that profound changes in environment occurred, even where the land was not turned to crop use. The wild land environment, both range and forest, was altered to an extent and at a pace that were catastrophic to its native inhabitants. Progressive drainage of the innumerable small lakes and ponds of western Nebraska and other Plains States destroyed a major breeding ground for waterfowl. Destruction of cover by fire and grazing in the lower hills of the California central valley began the process of restricting the range of the valley quail. The natural balance between summer and winter ranges was disrupted. The advance of civilization, expressed in the taming of the desert and wilderness, the conversion of range into crop land, and especially the depletion of remaining range lands, worked havoc with the natural environments of wildlife, restricting areas available to it, destroying its feed and water, and deteriorating its habitats.

RESTRICTION OF AREA AVAILABLE FOR WILDLIFE

Use of the better range lands for crop production, reclamation of submarginal lands, of waters, the disposal of lands by the States for immediate revenue, the transfer of lands into private ownership without restrictions on mode of use, and dry farming on submarginal lands, often ending in abandonment, have removed or destroyed areas formerly available for wildlife. Generally, settlement for crop agriculture was necessary and inevitable, but in other instances it has not proved to be economically successful. The abandonment of submarginal croplands has left in its wake considerable areas on which cover has been destroyed through plowing or other disturbance. Elsewhere, the continued use of poor lands, an economic loss in human effort, is resulting in injury to wildlife through removal of cover that with efficient use of the land, would have been available to wildlife.

The reduction in total area available to game would be serious enough in directly reducing populations, were it not for the loss of vital seasonal range areas, particularly winter ranges once so abundant.

Prior to settlement, buffalo and antelope occupied the plains and valleys; deer, elk, and mountain sheep were found in the foothills; and mountain goats preferred the inner fastnesses of the mountains. Deer and elk often summered on the foothills and lower mountain slopes and migrated to the plains and valleys for the winter, particularly when snows were heavy. Occupation of the lowlands by communities, fenced ranches, and livestock took over this natural winter range of game and forced them back into the mountains or onto remnants of their former range on the plains. Most of our big game animals today are found in the mountainous areas to which they are not especially well adapted, at least for year-long grazing.

RANGE DEPLETION

The forage stand on the principal forage types used by game during the critical seasons has been depleted over 50 percent in comparison with its virgin condition.

Overgrazing by livestock of the remaining winter game ranges in the foothills and plains has had the further effect of crowding the game onto mountain forest areas that are essentially summer range. Here the game was and often is forced into a less suitable environment in lower reaches of its former summer domain for winter feeding. The forage on many of these areas on the national forests has been reserved for game use, but the bulk of its winter range is under other control or in private ownership and migrating herds find the meager forage supply so vitally needed for wintering already cropped by domestic livestock.

This factor, coupled with the reduced range area, results in starvation and excessive loss from predators in severe winters. At such times ranchers have frequently divided their scanty hay supply with the game to relieve starvation. This situation applies generally throughout the range country. A specific example is in Montana, where it is estimated that in seasons of deep snow less than 5 percent of the gross national-forest area is available to game. This is so inadequate that an estimated 70 percent of the deer and elk are forced outside the forests in critical winters. Here, because of depleted forage on public domain and private ranges, many of them invade farm pastures and hay stacks, in order to survive.

Many instances illustrate the effects upon elk and deer herds of this restricted and depleted winter range. For example, the winters of 1930–31 and 1931–32 are estimated to have brought death to nearly 35 percent (and as high as 75 percent in some localities) of western Montana's deer; during the winter of 1932–33, on the South Fork of Flathead, 500 elk starved or were killed.

The two most obvious and glaring examples are the Sun River and the northern (or Yellowstone) elk herds. On Sun River, in the Lewis and Clark National Forest of Montana, a herd of elk on the Sun River game preserve was built up over a series of favorable winters to about 4,600 animals. This was a larger number than the available winter range could normally support. During winters of deep or crusted snow, such as that of 1919–20, feed areas were reduced to a few ridges blown bare of snow and isolated pockets or strips supporting browse on or near stream courses. In the fall of 1930 heavy storms drove a big proportion of the herd to the valleys, where 1,070 head were shot down by men and women on foot and on horseback, in farm wagons, and in city automobiles. Subsequent losses from starvation on the limited range area were very heavy, and by 1934 it was doubtful if the herd numbered more than 3,000 elk.

The northern elk herd, enjoying nearly 15 years of favorable weather conditions, increased to more than 15,000 by the fall of 1919. But that winter heavy snows fell early, forcing the animals down to range already cropped short by domestic stock. A toll of some 4,000 head was immediately taken by hunters. But as the winter advanced and snows became deeper and badly crusted, the slaughter during the hunting season was a merciful thing compared to the suffering

and loss which took place until spring brought relief. The winter of 1922–23 was also bad, and by the spring 1923 it was estimated that this herd which 8½ years earlier had numbered more than 15,000 was down to 8,000 or 9,000 head.

A further effect of range depletion is seen in the competition between two or more wildlife species through overcrowding. Thus on the Sitgreaves National Forest in Arizona the increasing numbers of a planted elk herd are competing more and more with mule deer in the use of winter range to the disadvantage of the deer. If the elk are allowed to continue increasing, it will be only a matter of time until the deer are exterminated, since the taller elk can reach higher on the juniper, a favorite elk and deer forage, and therefore can get food in winter after none is left within reach of the deer. This situation similarly applies to the Blue Mountain region of Oregon where the increasing elk are threatening to drive out the deer because of competition for forage on a depleted winter range.

Deterioration of habitat, through depletion of the range has furthermore resulted in decrease of upland game birds. A good example of this is in the thinning out of quail in the San Joaquin Valley region of California. Quail formerly inhabited the valley by the thousands, and the finest part of their habitat was in the brushy foothills. Overgrazing of these foothill areas and the extensive use of fire in an effort to improve forage has destroyed much of the perennial herbaceous vegetation and low shrubs that furnished not only cover but also food for the quail. The result is an estimated decrease of birds of 25 to 30 percent within the last 15 years. Decrease of quail for similar reasons has taken place at other points, such as along the Rio Grande and in the desert and semidesert areas of Arizona.

Whether the process of range depletion was accompanied by increase in species destructive to the range is uncertain. But at the least, the relative importance of rodents is greater on depleted than on normal range.

Rodents do a great deal of damage to the range in destruction of forage and therein are a contributing factor in reducing wildlife and impeding livestock production. Rodent damage looms large as a factor on ranges of the Southwest. For instance, Taylor (*141*) states:

> In some of our northern Arizona fenced plots, rodents, chiefly prairie dogs, have consumed, cut down, or prevented from growing, 69 percent of the bluestem, 81 percent of the blue grama, and 100 percent of the sand dropseed. In southern Arizona Rothrock grama and associated grasses in fenced plots have been reduced by jack rabbits and other rodents by 35 to 81 percent.

A single kangaroo-rat burrow may contain as much as 50 bushels of grass seed and there are at times as many as 10 to 12 burrows to the acre. In drought periods when all feed is needed by livestock as well as game and other valuable wildlife, such hoarding by rodents brings about an extremely critical condition. All feed may be exhausted months before new growth can come, increasing starvation losses of livestock and impairing the vigor of wildlife species.

Although settlement of the West has not been unfavorable to animals and birds in every case—as, for instance, a large increase in bobwhite that is evidently the result of the prairies being turned to

farm use. The net effect of profound and widespread alteration of environment is beyond doubt a breaking up of the distribution of many animal and bird species, so that mere islands remain; a reduction in the population per unit of area on lands still occupied; an exodus of the remaining individuals to less favorable environment; an upset of the balance between species.

Other Changes in Habitat

Destruction of former breeding areas by drainage combined with overshooting and the deterioration of feeding conditions by recurrent drought have brought waterfowl to a precarious state (*41*). Added losses attributable to misuse of land are being brought about by poisoning from a form of botulism, caused by the toxin produced by a common bacterium. The factors making favorable conditions for this causative organism are inadequate water supply and fluctuating water levels resulting in the creation, during periods of hot weather, of alkaline sinks and areas of shallow, stagnant water, mud flats, and their associated decaying organic matter in which toxin may be produced. Botulism in 1932 caused an estimated loss of one-quarter of a million birds at the north end of Great Salt Lake (*80*). Losses occurred at many other points within the range area but not to such extent as in the Utah-Idaho region. The range area lies in the path of two major waterfowl flyways of North America (fig. 75) and therefore is particularly important to waterfowl for furnishing food and resting places enroute.

The drainage of so many ponds, lakes, and marshes in the Plains States has wiped out most of the local breeding grounds for waterfowl, and much of the land drained has proved to be of very limited agricultural value. In fact, efforts are now being made to restore some of the 5,483,524 acres (*158*) that have been drained within the range area.

Likewise, because of reduced area by drainage and occupation of other submarginal lands, together with excessive trapping, fur bearers have been greatly reduced in numbers with consequent economic loss. As a general picture, F. G. Ashbrook, of the United States Bureau of Biological Survey,[36] states:

> The most amazing thing is that with a $500,000,000 annual turn-over in the retail fur trade even as late as 1929, no one should have started long ago to put the fur trade on a factual basis * * *. Already the annual retail turnover in furs has shrunken to $150,000,000, and the entire cause cannot be attributed to droughts, floods, and the financial depression.

To point out an example of the value of fur animals as an annual crop, speaking of swamp or marsh lands, Ashbrook further states:

> At present market prices (1935), the return on an acre from muskrat pelts alone would furnish an income of from $7 to $14 each season. No system of cropping this type of land would produce as much.

Fish suffered major reduction to a similar degree, particularly as range depletion reached an advanced stage. For example, many streams of the Wasatch Range in Utah originally had populations of native trout. Silting of the streams, brought on by overgrazing,

[36] Ashbrook, F. G. Fur resources—the stepchild of conservation. An address at the Sixth Annual National Retail Furrier Convention and Trade Exposition, held at Buffalo, N. Y., July 1935. 4 pp. 1935. [Mimeographed.]

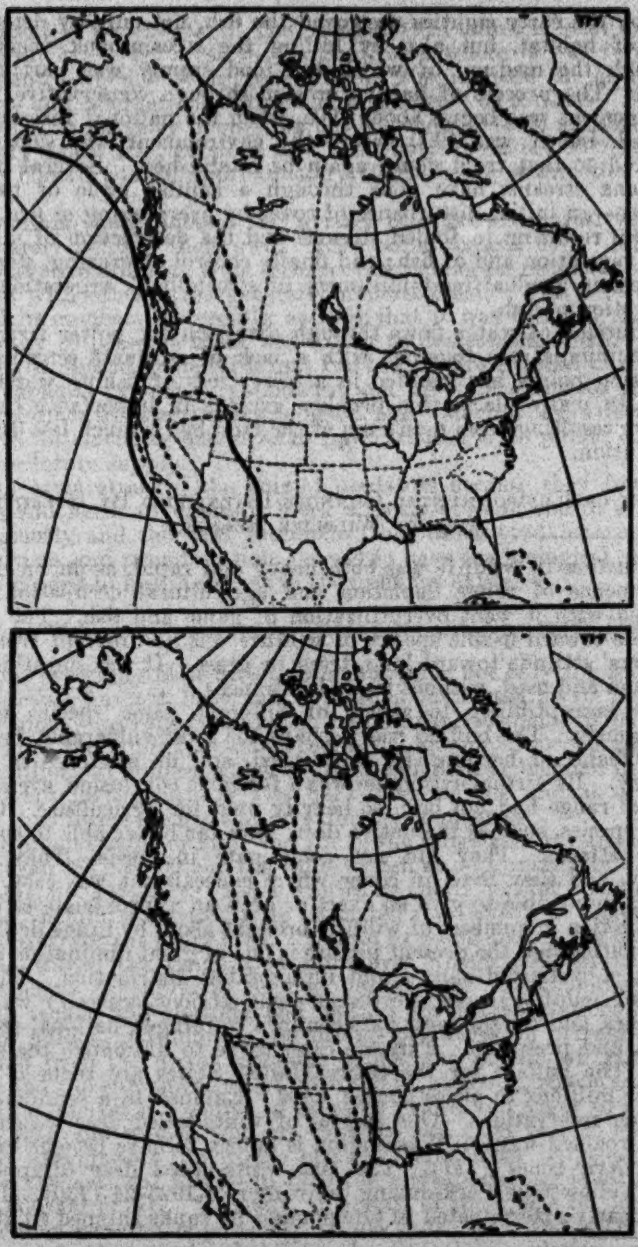

FIGURE 75.—Two principal waterfowl flyways through the range country emphasize the need for an adequate cover to provide watershed protection. The flyway lane in each case is indicated by heavy lines and the tributary migration routes are shown by arrows. Upper, Pacific flyway; lower, central flyway. (From "The Waterfowl Flyways of North America", U. S. Dept. Agr. Circ. 342.)

had by the early eighties destroyed the fish, not only by deterioration of habitat, but also by killing the stream-bank vegetation through the medium of which the food supply was partly provided. The process of halting erosion through conservative range management was begun about 1905, when the national forests were created, but it was 1920 before the environment was sufficiently restored so that trout could again be established. Several of the Montana streams have gone through a similar cycle of natural balance—an initial disturbance of cover by overgrazing or fire; then erosion, resulting in fouled streams and the destruction of stream-bank vegetation and of fish; and finally control of grazing, stopping of erosion, gradual reestablishment of stream-bank vegetation, and restoration of fish.

Reduction of water flows through diversion for power irrigation and municipal use together with a lack of adequate screening at diversion points has resulted in a heavy loss of fishing water and fish. In many places this problem exceeds in importance that of factors resulting from man's use of the land but is much less difficult of solution.

Effect of Environmental Changes Intensified By Overutilization of Wildlife Resource

Reduction in wildlife was both heavy and rapid, as an inevitable consequence of range depletion and agricultural occupation; but coupled with it went overutilization of game and fish. The early attitude toward usable species of wildlife was no different from the pioneers' attitude toward land, trees, or grass. It was something to be taken and used, without let or hindrance.

The susceptibility to attack of different game species varied enormously. The buffalo was perhaps the most vulnerable, because of its habit of herding, its slow speed, and its existence in open country. Its virtual extinction was a foregone conclusion, even if its natural range had not been so heavily used for agriculture. Other game species, such as the native deer, were far better able to survive man's attacks. They did not congregate in herds. They were speedy, and they lived in cover where concealment was easy.

It is impossible to give an exact or even an approximate estimate of reduction in numbers of wildlife brought about by range depletion and hunting, but the present picture is one of great diminution of all forms, a restricted range, and unfavorable distribution. The remaining wildlife is overcrowded in some sections, scarce or wanting in others, and for the most part confined to refuges, national forests, parks, and preserves. Extreme cases serve to dramatize the situation. The buffalo for the entire United States are reduced from former millions to an estimated 4,400 [*] confined to a semidomestic state on reservations. One species of white-tailed deer which formerly roamed western Washington is known to have become extinct in modern times (*141*). The last white-tailed deer disappeared from Yellowstone Park during the winter of 1923–24 (*130*). It has been nearly exterminated in Oregon and its ranks thinned to alarm-

[*] Figures furnished by U. S. Biological Survey, according to a census taken by the American Bison Society issued under date of Jan. 1, 1934 (*8*).

ing extent in Washington. The prong-horned antelope is still scarce or absent over vast areas in the Southwest where it was formerly abundant, although it is generally on the increase on and near refuges and reservations within the range areas as a whole. Where estimated as formerly numbering not less than 30 to 40 millions, and possibly more (*98*), antelope now total only about 66,000 [98] for the entire United States, approximately 60,000 being within the range area.

Mountain sheep, moose, and grizzly bear are comparatively few and barely holding their own. (See tables 62 and 63.) Elk and mule deer are suffering from serious overstocking on restricted winter ranges with other areas generally understocked. Elk were so reduced in numbers as recently as 1904 that it was believed that the only way to preserve them was to try to domesticate them. Most species of upland game birds and fur bearers are reduced to scattering remnants of former abundance and are continuing to decline. Many former fish streams are depleted, and waterfowl have decreased to such an alarming extent as to have aroused wide public concern for the future supply.

Man early attacked the animal predators because they found in flocks and herds of domestic stock a ready-at-hand source of feed. The grizzly and the wolf succumbed, but other predators, such as the coyotes and mountain lion, proved to have the biological adaptability needed to insure success in the fight for existence.

Reduced Wildlife Presents an Important and Neglected Problem

Game especially is of direct economic value not only for food but also because hunters, fishermen, and others attracted by its presence bring money into the community. From the viewpoint of national economics, our wildlife resource represents an annual income running into millions of dollars, which is capable of further increase through intelligent management. The harvesting of the annual crop of game thus forms the basis of an extensive commerce.

The annual value of meat and fur in the range area is estimated at more than $87,250,000 and the value of fish at approximately $4,700,000 (*154, pp. 495–496*). Expenditures by sportsmen for hunting and fishing, including licenses, were estimated for 1930–31 at better than $40,300,000 for the range area. Tourist expenditures on the national forests within the range area were over $155,000,000 in 1930–31. Sportsmen's expenditures include purchase of arms, ammunition, fishing tackle, and clothing and outlays for transportation, board, hire of guides, and hunting and fishing privileges on private lands.

Aside from the direct economic values, the pursuit of game for sport and the enjoyment of wildlife for its aesthetic, educational, or scientific interest is a source of renewed health and vigor to a great many men and women who are thus induced each year to spend a period of vigorous life in the open. The number of people that visited the national forests in 1930 for recreational use is estimated at 31,000,000 (*149*). To many, if not all of these, one of the main attractions was the opportunity to see deer, bear, and other wild creatures in their native habitat. Increase in population, greater

[98] Estimate based on figures given in New York Zoological Society Bulletin, 1932 (95).

accessibility because of the automobile and good roads, and the time for greater leisure will result in a growing demand for wildlife enjoyment.

A further important value of wildlife is the beneficial effect on range lands—enrichment of soil by the work of burrowing mammals; distribution of seed by birds; influence on streamflow by the work of beaver, where scientifically controlled, in checking rapid run-off and making more favorable conditions for the occupation of streams by fish (*113*); and insect and rodent control by birds and fur bearers. The destruction of insects by birds within the range area is given an estimated value of $208,700,000 in protecting agricultural crops (*154, pp. 495–496*).

This general situation, as affecting economic and social values, is reflected in loss of the fullest enjoyment and profit to be obtained through a balanced use of the range and a sufficiently abundant wildlife to provide hunting, fishing, and recreational and aesthetic benefits commensurate with local and national needs. Often the presence of wildlife is a major attraction of a locality and a source of revenue to the community in the expenditures by tourists and hunters. The large deer herd in the Kaibab National Forest is a great attraction annually to the many visitors to the Grand Canyon. In the Southwest there is so much desert waste land that the presence of game in the mountain areas becomes a major attraction and therefore of great economic importance. Similarly, in the mountainous region of Montana, where so much area is of little use to livestock, is inaccessible, and has only low-value timber, the presence of game and desirable fishing streams is a real asset. The more support a community receives from outside revenue, such as may be attracted by the presence of wildlife, the less it needs to tax its local residents. Aside from this, the presence and maintenance of wildlife is of benefit to the local resident for his own enjoyment. Its curtailment, therefore, beyond a reasonable need for other use of land is a distinct loss.

Recently, because of the serious decrease in waterfowl, a general cut in the bag limit for ducks had to be made throughout the United States and the hunting season shortened. This entailed a loss not only to the hunter in limited enjoyment, but to the community as well in loss of revenue. The decreasing number of fur bearers and game birds, and the increase of depleted trout streams, have resulted in the loss (to the farmer and his son, particularly, but also to others) of the profit and enjoyment that comes from trapping, fishing, and hunting. Likewise even to the city dweller there is loss of opportunity for healthy recreation, whether it be in whipping a stream for trout, gunning for rabbits or quail, or observing big game in its natural environment. And to the tourist and sportsman there must surely be a disappointment in viewing an overgrazed range as a setting for wildlife, or in failing to see the wildlife forms that had been anticipated. Thus the fullest economic and social values of wildlife are affected adversely by the present condition, and the need of a remedy is indicated.

For decades the process of direct depletion of wildlife continued without serious effort to halt it. Naturally enough, the initial preoccupation of the pioneers with the struggle to subdue a new country, and the easy assumption that game and fish, like forests, grass, and

farm land, were inexhaustible, left only a few to think of future problems. Man necessarily lived in the here and now.

Prior to 1900 there was very little thought of the need for protection of wildlife. It had been so abundant that restrictions were not deemed necessary. It was not until the end of the game resource was definitely in sight that any action toward wildlife conservation was sought.

First steps were State game legislation to establish seasons and bag limits for game and the creation of control and enforcement under a county and later State game-commission system. A contemporary and most vital development was the building up of favorable public sentiment in favor of game conservation and law enforcement. A further step was the establishment of many State and Federal game refuges and preserves for protection of wildlife. This was followed by transplanting and propagation of game stock; fish were replaced in depleted streams; game animals were reestablished on depleted areas in various localities; and replacement and supplementing of upland game birds were brought about by introduction of exotic species, such as the ringneck pheasant and Hungarian partridge.

Defects in Theories Adopted in Wildlife Conservation

The early attempts at wildlife management were based (as is, indeed, the general pattern of action to date) on the premise that with merely restrictive laws and their effective enforcement, perpetuation of any species could be accomplished. That this whole approach to the problem of wildlife management is biologically unsound has become increasingly evident, as populations of wildlife—particularly of game birds, animals, and fish—have continued to decrease, despite more and more laws and more and more officers to enforce them.

WILDLIFE NOT REGARDED AS A CROP

One underlying difficulty has been that the public mind has had no appreciation of wildlife as a crop, the produce or surplus of which is to be annually harvested, and hence has had little concept of the possibilities of wildlife management. Leopold (*85*) briefly defines game management as "the art of making land produce sustained annual crops of wild game for recreation use." This implies not only conservation in its broadest sense and correction of past abuses that come about as a result of settlement and lack of understanding but also the control of numbers in accordance with the available feed.

An added factor in the overbalance of game has been the inadequacy of control of numbers under the average buck law. This fails to consider breeding needs, results in an overabundance of does, and a corresponding large increase in the herd that contributes to local overstocking. In many places, as for example the Modoc, Lassen, and Shasta National Forests in California, owing to overprotection by refuge, predatory-animal control, and bag limits, the deer population has grown beyond the grazing capacity of the winter ranges. These factors of overprotection have also applied in many other cases of game overpopulation, such as on the Kaibab Plateau and on the Gila National Forest.

Predator control must not only stop short of elimination of predators; it must avoid the equally disastrous error of permitting too large a number of predators to remain. For example, insufficient control or kill of mountain lions in California has resulted in a great increase of these predators on the coast ranges and in the northern part of the State. This is contributing to material reductions in what until recently were rather large herds of deer and to what are now understocked conditions on the deer ranges in these sections, which being close to San Francisco and other bay cities furnish sport for thousands of hunters. The importance of predators in rodent control, moreover, should not be overlooked. For example, in Colorado it is felt that weasel, if properly protected, would accomplish in rodent control as much as or more than the present poisoning methods. That weasels are not protected in Colorado and are now scarce is considered a contributing factor in the increase of rodents in that State.

WILDLIFE TREATED APART FROM ENVIRONMENT

Another difficulty in management has been that legal theory separated wildlife from its environment. Thus arose inevitable conflict in administration through the claim to jurisdiction over game by the States, irrespective of ownership of the land occupied by the game. The legal status of the game on nationally owned or private lands has never been definitely settled. Too abundant game may be destructive to forest reproduction or to watershed and may seriously interfere with the proper regulation of the grazing of domestic livestock essential to the maintenance of established communities. Proper game management calls for the maintenance of numbers on the basis of available forage and with due regard to other local needs. Often the necessary killing of surplus game on overpopulated ranges runs counter to the provisions of State game laws. Under the present system of divided authority it is very difficult to work out an effective reconciliation of the points of conflict.

This is illustrated in the problem of reducing surplus elk in the Pecos herd on the Santa Fe National Forest in New Mexico (*127*) and the Sitgreaves herd on the Sitgreaves and Coconino National Forests in Arizona (*110*). Here again the management problem is one of holding numbers to the grazing capacity of the range in full consideration of livestock and other crop needs. The removal of surplus animals is not provided for under the present State control of game. On the Sitgreaves the elk increased from an original plant of 75 in 1913 to approximately 3,300 head in 1934. The optimum number to be maintained on this area is placed at 2,000 head. On the Santa Fe, the elk increased from an original plant of 47 in 1915, of which 18 are supposed to have survived, to an estimated 1,100 in 1934. The optimum number to be maintained here is placed at 1,000 head. The need of management control and reduction of surplus game on the above areas is apparent but meets with the difficulty of conflict with State law.

Another environmental obstacle in wildlife management in the West is the diversification of ownership of the land which has greatly complicated any unified program of management. National parks furnish a haven for wildlife and can be of great value in its

production, if a proper balance is maintained under a uniform and correlated program of management applying to all areas. National forests have immense areas of land occupied by wildlife that are little if at all used by domestic livestock (fig. 76). In Montana

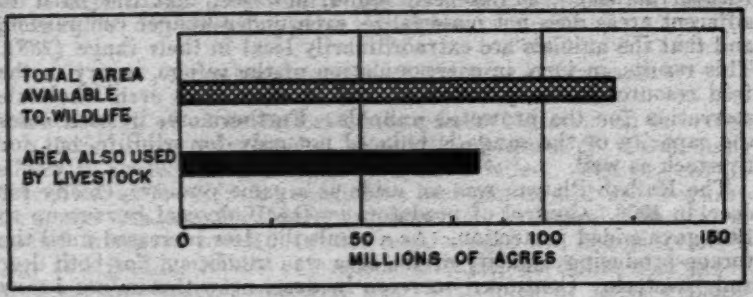

FIGURE 76.—National-forest areas available to wildlife, including those used by livestock.

alone is 9,289,104 acres of such land, representing 57 percent of the net area of national forests in the State. Such lands, in addition to those closed for game, recreation, watershed protection, or other use, are inaccessible to livestock because of heavy timber, down timber, or rugged topography. Because of this large available acreage the setting aside of separate areas for wildlife has been necessary only to meet specific needs, such as particular breeding grounds, winter range, etc. On lands properly grazed by livestock there will ordinarily be abundant cover and sufficient food supplies to maintain a reasonable stocking of wildlife. For example, the national forests of Colorado are estimated to afford adequate summer range for two or three times the present number of game animals without conflict with livestock, provided sufficient winter range is made available for the wildlife on adjoining public domain.

On private lands there is little to encourage the owner to protect wildlife other than his natural liking for it. Still, if the owner provides some food and cover in wood lot, windbreak, or hedge, the land can contribute both to private use and wildlife supply, particularly of small-game species such as quail, grouse, pheasants, and rabbits.

On the open public domain there is a more serious situation in wildlife maintenance. Owing to heavy overgrazing by livestock, food and cover for wildlife have been removed or greatly depreciated. Management of the forage resource of the public domain is greatly needed and should be coordinated with that on other lands for development of wildlife in proper relation to other resources and use values. This will add materially to the economic and social enjoyment of the region and Nation.

WILDLIFE REFUGES NOT UNIVERSAL SOLUTION

As operation of restrictive laws failed, the theory of complete protection on specific areas became established, its proponents overlooking the fact that protection from hunting alone may defeat its

own purpose. Protection was the underlying idea in the original concept of the game refuge. It was believed that large refuges, permanently established, would serve as breeding grounds for game, from which increases would drift on to adjacent areas and there furnish hunting. It has been found, however, that this drift to adjacent areas does not materialize, even under hunger compulsion, and that the animals are extraordinarily local in their range (*188*). This results, in turn, in overpopulation of the refuge, injury to the feed resource in many instances, and in some cases even wholesale starvation for the protected animals. Furthermore, in such cases the capacity of the range is reduced not only for wildlife, but for livestock as well.

The Kaibab Plateau was set aside as a game preserve, chiefly for deer, in 1906. Control of predators by the Biological Survey up to 1928 gave added protection. As a result the deer increased until the forage-producing capacity of the area was insufficient for both deer and livestock. Continued increase in deer, notwithstanding heavy reductions in livestock totaling 77.8 percent between 1910 and 1930, resulted in great damage to the more valuable forage plants and young forest trees. By 1929 biologists estimated that it would take the vegetation, much of it of especial value for the deer, a minimum of 50 years under practically complete protection to regain its original condition. Action has been under way for several years to remedy the situation, and the excess population has already been reduced.

A large area of mountainous country on the Gila National Forest, because of latitude, elevation, and vegetative cover, is peculiarly adapted to the production of deer (*102*). It is also used by cattle. To protect calves the cattlemen set about to exterminate the mountain lion. There are no available statistics regarding the number of lions removed, but it is known to be large. This destruction of mountain lions served also to protect the deer. Since the area is relatively inaccessible to hunters, the inevitable occurred. The deer herd increased prodigiously, with the result that the cattlemen began to complain that the deer were overrunning their range and threatening to put them out of business. Here, as on the Kaibab, it has been necessary to correct the situation by removing the surplus deer, and also to reduce the number of livestock.

TRANSPLANTING OF WILDLIFE

The artificial planting of areas to game, while often an effective aid in restoring and distributing wildlife, has not always been wise. This is illustrated in the planting of elk on the Pleasant Grove division of the Wasatch National Forest in Utah. Here elk were introduced in a narrow foothill area bounded on one side by the inaccessible Timpanogas Mountain range and on the other side by lands occupied by farms and ranches. These adjoining properties have intense need of the range for domestic livestock. The elk here, which numbered 18 head in 1920, had increased to 209 head by 1934. The restricted range is too small for this increase, particularly for winter forage, with the result that the elk seek food in raids on orchards, gardens, and haystacks of the nearby ranches. The elk

in this instance seriously conflict with the local needs in use of range for livestock, besides doing damage to farm properties.

Widespread attempts to replace depleted stocks of native upland birds by importation of exotics have been only partly successful. To a large extent these efforts beg the question of the real underlying causes of decreasing game population.

LACK OF BASIC KNOWLEDGE OF WILDLIFE A HANDICAP

Underlying all other factors of the present situation on the range is a lack of basic knowledge of wildlife because of which many efforts in protection and restoration have failed. The present information as to wildlife populations and annual kill are fragmentary and inadequate. Much fundamental biological research is needed in regard to wildlife interrelationship, life histories, breeding, and feeding habits of various animals, environmental needs, propagation, enemies, diseases, etc. Principles of good management demand that working plans, not only for the development of the wildlife resource but for its coordination with other forms of land utilization must be based on sound, fundamental facts.

WILDLIFE ADMINISTRATION NOT HANDLED AS A BIOLOGICAL PROBLEM

Because wildlife conservation was based solely on restrictive laws, it was natural that the commissions and boards created to supervise fish and game work, and the field officers employed for law enforcement, were seldom selected for their training in the biological sciences. Just how much might have been accomplished had the States generally used men with professional qualifications rather than political appointees, is perhaps an open question. At least, earlier and more forceful recognition of the underlying structural defects in the edifice of State game and fish management would likely have come.

WILDLIFE MANAGEMENT UNDER LEGAL PATTERN SELF-DEFEATING

The logical outcome of a purely legal approach to wildlife management is either the virtual extermination of species that hunters and fishermen unfailingly bring about, against their own true interest and desire, or the virtual end of hunting and fishing as complete closure to taking becomes necessary through failures inevitable from the very structure of the accepted theory. The yearlong closed season on many species in the range States, forced as a last desperate measure to prevent extinction of valuable game species, testifies alike to the self-defeating nature of management by restrictive laws and to the decreasing opportunity for hunting and fishing.

VITAL IMPORTANCE OF ENVIRONMENT PROVED BY NATIONAL-FOREST EXPERIMENT

That maintenance or restoration of an approximately natural environment is the first essential in restoring wildlife populations has been proved on a large scale on the national forests. For on these public properties, although the taking of wildlife has been

wholly controlled by State law, an essentially natural environment has been maintained or restored.

Probably no single factor has had a more important effect upon the rehabilitation of the wildlife resource on the western range than the establishment of the national forests. Withdrawal of lands for forests insured the maintenance of a suitable wildlife habitat, which was so essential in that critical period if game was to be perpetuated in the face of a rapidly advancing civilization.

TABLE 60.—*Refuges and reserves for wildlife on the western range, inside and outside national forests*[1]

State	Inside national forests					
	State-owned		Federal-owned		Under administrative restriction	
	No.	Acres	No.	Acres	No.	Acres
Far western:						
Arizona	43	992,444	3	899,450		
California	22	1,092,889	2	20,770	5	93,720
Colorado	12	2,042,280			20	418,178
Idaho	26	3,515,787			14	1,235,240
Montana	23	1,214,903			30	1,139,448
Nevada	10	952,240				
New Mexico	49	1,144,983	1	45,615		
Oregon	14	795,805			3	170,600
Utah	11	1,261,680				
Washington	25	2,027,194			2	55,922
Wyoming	20	2,845,445	2	84,450	19	337,033
Range portion of Plains States:						
South Dakota	1	34,000	2	81,195		
Nebraska	1	320,000				
All States	280	19,373,736	11	1,027,305	117	3,549,940

State	Outside national forests				All areas	
	State-owned		Federal-owned			
	No.	Acres	No.	Acres	No.	Acres
Far western:						
Arizona	6	909,220	2	222,827	56	2,910,991
California	11	844,733	5	80,284	55	2,820,907
Colorado			5	337,260	66	3,417,813
Idaho	4	448,960	2	30,240	46	5,313,448
Montana	6	[2]947,797	7	96,686	77	3,860,789
Nevada	13	4,304,870	6	899,985	27	6,709,348
New Mexico	61	1,217,644	2	91,906	113	2,500,050
Oregon	9	3,361,280	5	344,160	31	4,301,874
Utah	6	801,000	3	79,227	20	2,022,017
Washington	91	1,838,882	9	1,720	126	3,923,718
Wyoming	7	940,999	5	62,413	53	3,937,311
Range portion of Plains States:						
North Dakota	30	86,127	2	11,760	33	79,082
South Dakota	12	138,910	1	12,000	17	265,778
Nebraska	9	[3]71,540	1	40,760	11	312,140
Kansas	2	4,440			2	4,440
Texas	26	2,727,404			26	2,727,404
All States	315	19,143,399	55	1,993,064	776	44,200,260

[1] Sources of data: U. S. Department of Agriculture, Bureau of Biological Survey, Bird Refuges and Big-game Preserves Administered by the Bureau of Biological Survey, Wildlife Research and Management Leaflet BS-16, 7 pp., illus., 1936 (mimeographed); and Forest Service annual fish and game reports, 1935.

[2] 7 area figures not available.

[3] 1 area figure not available.

Table 60 shows the refuges and reserves for wildlife inside and outside the national forests of the western region for 1934. The 44.3 million acres estimated for these tracts amounts to 4.5 percent of the total land in the range country. In addition, as shown in table 61, there are about 20.5 million acres of public and private lands lying inside and outside the national forests that have been recommended by the Forest Service and the Biological Survey for present and future acquisition for the use of wildlife. Thus, only 7 percent of the range country, or 65 million acres, is available in refuges and proposed special areas for the use of wildlife. In addition to these designated wildlife areas, however, there are about 845 million acres of grazing, cultivated, and other land, or 86.7 percent of the total western land area, that under proper use may be made jointly available to the production of wildlife, particularly of the smaller species, such as birds, fur bearers, and fish. Of this area, 721 million acres may be considered as jointly usable by wildlife and domestic livestock. The importance of securing a suitable wildlife management on such an acreage is apparent.

TABLE 61.—*Recommended additional areas for wildlife within the range area inside and outside the national forests*

State	Areas inside national forests		Areas outside national forests		Waterfowl areas [1]	All areas
	Submarginal, now occupied	Private land in grazing, not occupied	Submarginal, needed for wildlife and watershed	Public domain needed as supplemental range	Desired projects	
	Acres	*Acres*	*Acres*	*Acres*	*Acres*	*Acres*
Arizona				844,000		844,000
California	11,740	55,100	304,540	1,210,000	10,778	1,591,268
Colorado	68,243	271,960	2,732,776	5,441,000	7,240	8,519,469
Idaho	13,406	36,870	288,696	827,861	77,827	1,195,612
Montana	20,000	188,000	202,189	68,783	48,340	330,308
Nevada	695	21,650	12,640	1,827,635	22,560	1,885,230
New Mexico		200,435		688,000	36,033	940,048
Oregon				1,273,000	130,262	1,403,262
Utah	4,043	48,735	471,000	1,732,260	28,589	2,278,727
Washington				188,000	29,551	217,551
Wyoming	9,748	15,770	223,821	515,462	19,025	791,066
North Dakota					124,000	124,000
South Dakota	5,150	66,000	141,000	30,460	14,303	261,103
Nebraska					72,984	72,984
Texas					4,811	4,811
Total	130,125	1,097,789	4,442,662	14,191,814	637,326	20,858,946

[1] U. S. Department of Agriculture, Bureau of Biological Survey, Summary Report of Land Acquisition Program, Nov. 15, 1935, 5 pp. (Photostated from typed sheets.)

Under protection on the national forests, as also on national parks and State preserves, the population of the principal game species have made phenomenal increases during the past 25 years. More efficient law enforcement and consideration of wildlife problems by States and other agencies concerned have contributed to this improve-

ment. Table 62 shows the estimates of wildlife on the national forests within the range area for 1934. Figure 77 and table 63 show the trend of big-game populations on national forests since 1924. It is estimated that the increase in numbers of all big-game animals on the national forests during the period 1924–34 is about 77 percent.

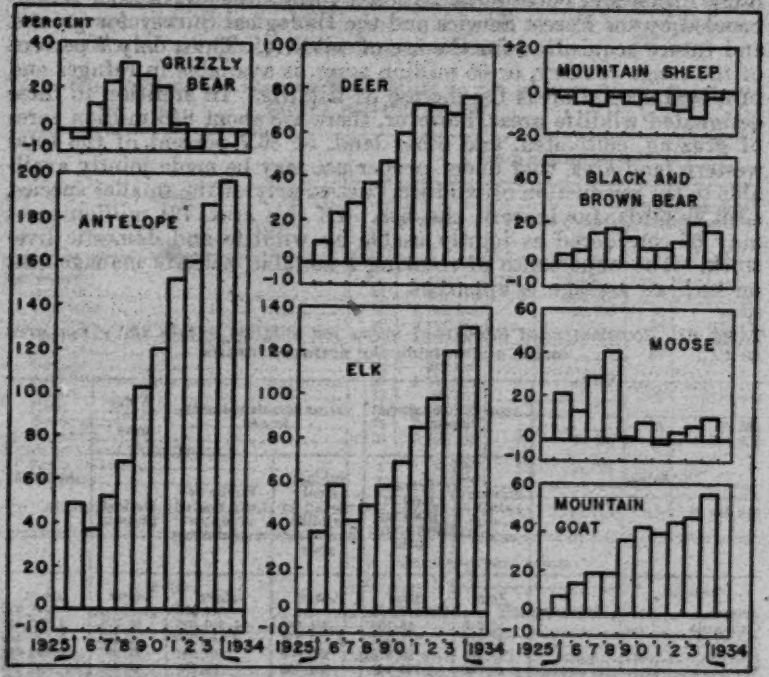

FIGURE 77.—INCREASE OR DECREASE OF BIG GAME ON NATIONAL FORESTS.

The decrease in moose and grizzly bear from the 1928 peak is due partly to a change in the method of taking the census and partly to cyclic changes in abundance from unknown causes.

This development is effective as far as it has gone, but it is by no means adequate to growing needs. It is an advance toward securing the social and economic values involved, but a further step is now needed, namely, to obtain management of the wildlife resources on a more comprehensive plan that will cover the range area as a whole and be based upon an environmental control determined by research. Leopold (*85*) states:

> Both scientists and sportsmen now see that effective conservation requires, in addition to public sentiment and laws, a deliberate and purposeful manipulation of the environment—the same kind of manipulation as is employed in forestry. They are also beginning to see that in game, as in forestry, this manipulation can be accomplished only by the landowner, and that the private landowner must be given some kind of an incentive for undertaking it.

TABLE 62.—*Estimates of wildlife on national forests within the range area, Dec. 31, 1934* [1]

Animals	Arizona	California	Colorado	Idaho	Montana	Nebraska	Nevada	New Mexico	Oklahoma	Oregon	South Dakota	Utah	Washington	Wyoming	All States
Big-game antelope	5,040	2,220	224	4,116	1,106	.....	220	980	.....	480	12	100	.....	615	15,013
Black or brown bear	700	11,431	3,362	4,000	5,642	.....	2	1,275	4	5,621	.....	911	5,226	1,783	41,706
Grizzly bear	7	.....	3	35	455	.....	.....	3	.....	.....	.....	4	6	120	573
Deer	91,000	256,950	52,870	63,287	55,777	167	11,208	97,400	1,000	92,677	5,051	20,980	34,543	37,215	574,344
Elk	4,721	121	15,276	11,706	20,430	.....	60	1,902	345	12,096	223	3,180	3,206	40,795	120,980
Moose	.....	.....	.....	207	1,986	.....	.....	.....	.....	.....	.....	.....	.....	2,478	5,080
Mountain goats	.....	.....	.....	3,463	4,190	.....	.....	.....	.....	.....	18	.....	5,072	.....	12,742
Mountain sheep	188	442	3,002	1,981	1,981	.....	170	106	.....	80	.....	159	6	4,095	11,630
Total	101,706	271,184	81,437	90,454	91,126	167	11,708	101,016	1,349	107,776	5,308	24,910	88,063	77,010	1,006,147
Predatory coyote	.....	67,196	19,720	23,210	16,823	330	8,875	.....	125	20,559	1,900	13,247	14,145	9,745	196,114
Cat or lynx	.....	25,270	5,178	4,950	3,013	.....	2,235	.....	10	6,052	1,080	4,466	4,800	1,570	58,051
Mountain lion	.....	1,511	341	515	299	.....	71	.....	.....	446	3	768	492	41	4,786
Wolf	.....	.....	10	106	7	.....	.....	.....	.....	128	.....	7	26	10	290
Total	.....	93,976	25,257	28,781	20,142	330	11,281	.....	135	27,229	2,983	18,488	19,463	11,366	259,243
Fur-bearing badger	2,260	9,215	4,862	11,280	.....	38	1,215	2,400	.....	3,330	1,015	5,726	1,208	2,275	45,024
Beaver	1,026	96	42,230	13,228	16,129	.....	126	1,510	.....	4,214	1,060	3,788	6,731	9,035	104,369
Fox	20,200	29,870	5,817	5,047	1,851	.....	462	6,600	80	949	.....	1,217	830	1,857	76,729
Marten	.....	15,010	7,877	11,227	10,080	.....	30	.....	.....	4,025	.....	1,462	19,256	6,155	75,021
Mink	270	10,288	7,633	12,183	9,206	.....	265	850	.....	11,960	27	2,156	10,195	3,575	68,608
Muskrat	.....	.....	26,586	1,228	.....	100	.....	.....	.....	12,350	1,500	480	15,220	10,240	68,204
Otter	.....	150	8	765	239	.....	.....	.....	.....	585	.....	.....	207	23	2,184
Raccoon	5,985	4,970	.....	.....	.....	.....	.....	1,760	760	11,700	500	.....	920	288	26,970
Skunk	67,100	24,200	5,720	40	.....	100	.....	17,100	2,200	10,838	4,760	1,200	12,800	1,940	137,988
Weasel	1,480	8,035	47,190	23,260	.....	.....	1,275	1,675	.....	21,720	5,550	14,040	24,710	18,275	166,410
Total	78,561	96,833	149,236	87,808	37,643	238	3,908	32,275	3,100	90,369	13,223	30,109	107,183	53,409	706,017
All animals	180,267	462,973	255,933	207,033	148,931	732	26,891	134,291	4,584	226,054	20,230	133,507	155,699	141,785	2,180,407

[1] In addition: California, 280 ringtail cat and 610 fisher; Montana, 216 buffalo and 6 caribou on national-forest land; Oklahoma, 97 longhorns on national-forest land; and Oregon, 260 ringtail cat.

TABLE 63.—*Numbers and trend of big game on national forests within the range area, 1924–34*

Species	1924	1925	1926	1927	1928	1929
Black and brown bear	37,752	39,640	40,922	42,273	44,286	43,767
Grizzly bear	734	808	816	880	947	907
Deer	622,702	642,411	654,981	620,615	675,144	726,177
Elk	69,266	71,220	62,263	74,042	78,075	83,234
Moose	4,561	5,116	5,142	5,982	6,421	4,894
Mountain goat	8,264	8,267	8,415	9,524	9,796	11,000
Mountain sheep	12,022	11,482	11,265	11,242	11,224	11,328
Antelope	5,026	7,542	6,942	7,066	8,404	10,219
Total	813,329	899,171	781,475	782,442	835,903	899,508

Species	1930	1931	1932	1933	1934
Black and brown bear	40,651	40,257	41,961	43,200	43,706
Grizzly bear	870	747	864	721	672
Deer	788,540	802,200	849,300	834,005	874,944
Elk	88,023	96,700	102,745	115,074	130,830
Moose	4,904	4,491	4,622	4,531	5,000
Mountain goat	11,506	11,262	11,736	11,868	12,743
Mountain sheep	11,096	11,066	10,980	10,926	11,230
Antelope	11,143	12,726	13,130	14,488	15,033
Total	965,200	1,000,907	1,035,319	1,036,955	1,094,167

The unmistakable trend of increase in wildlife population under natural environment, even with the handicap of ill-considered State laws, is in sharp contrast to the general trend of decrease on the more heavily depleted lands in other ownerships and under other managements. This long-term and widespread experiment, although the results simply confirm well-known biologic and ecologic laws, yet points the way to a fresh start in wildlife management.

MAJOR PROBLEMS IN WILDLIFE MANAGEMENT

A fresh start toward restoration of wildlife populations—particularly of game birds and animals, and of fish—requires, first of all, more general acceptance of established biologic and economic facts. These include the following:

1. Wildlife is a product of environment and each species can succeed only under a specific environmental pattern, made up of determinable and (except for climate and elevation) controllable elements.

2. Management of wildlife starts with and is limited by management and manipulation of environment.

3. Lacking established legal power to force conservative management of land and environment, attempts to manage wildlife solely under restrictive game laws can succeed only to the degree that environment is independently maintained and improved. The key to wildlife management rests with land ownership.

4. The legal theory which places title to wildlife in the State, leaves little direct incentive to private or other public owners to manage land in a way to favor wildlife.

5. Game species must be handled on a crop basis, with the annual take adjustable to and definitely set on the basis of annual increase. The problem differs not at all in this respect from that of maintaining continuously productive flocks and herds of domestic birds and animals.

6. In addition, successful wildlife management is a problem in applied biology, and requires, first of all, a factual basis, and secondly, professionally trained men to apply the facts. For game species, such questions as sex ratio, best season for taking, desirable degree of predatory control, and needed environmental changes, must be handled on a flexible basis, adapting action to needs of particular areas at particular times.

7. Given a suitable environment, and management on a crop basis, most wildlife species can succeed on lands used by other wildlife species, and by man and his domestic animals. If handled as a part of conservative multiple-purpose land management, wildlife populations can be maintained or increased. Deliberate attention to such things as reservation of feed for wildlife, both on summer and winter range, are simply a part of good land management.

8. The logical outcome of theories and methods of wildlife management which depend on detailed and rigid laws, as heretofore applied, is further reduction in population.

Restoration of far larger, more widely spread, and more readily available populations of game birds, animals, and fishes, is the heart of the wildlife problem. Hunting and fishing available to all, have been a part of the American tradition. Maintenance of this opportunity for the tens of millions of actual or potential hunters and fishermen who cannot afford to travel far, nor to pay high fees for the privilege, is of increasing importance in the face of increasing leisure.

Inevitably, public lands, managed to produce takable crops of game and fish, must furnish the major opportunity for free public hunting and fishing. The guides to future and effective restoration programs are clear. Restoration of environment, whether of range or forest—a function of land ownership—is the key to restoration of wildlife. Management of wildlife as a crop, in accordance with biological facts and laws, by professionally competent men, is inseparable from management and manipulation of environment and is therefore also a function of land ownership.

IN SUPPLYING AREAS FOR RECREATION

By L. F. Kneipp, Assistant Chief, Forest Service

The Social Need

Like other organisms, man has certain ecological requirements, except that in his case they are not only physiological but also psychological. In the course of his history man has been so influenced by certain natural associations that long-continued separation from them tends adversely to affect his body, his mentality, and his spiritual outlook.

Modern life operates largely to effect such a separation. The intimate contact with elemental nature under which man mainly developed his present physical and mental qualities gradually has been succeeded by more confined modes of life, productive of greater comforts and conveniences and conducive to a more complex economy and culture but in some ways less stimulating to the body and mind. Particularly is that true of the urban dweller, who not only largely is insulated from natural forces and influences but is subject to a tempo and tension that impose heavy demands upon both physical and nervous energy.

The consequences of that condition are detrimental not only to the individual but to society collectively. They impose losses not only spiritual and social but also economic. The justice and desirability of collective social action to check and correct the condition are now generally recognized by both private and public agencies. Private recognition consists of provision to the worker of time in which to recuperate by renewal of associations with natural elements and forces; public recognition takes the form of provision of environments within which such associations most effectively and profitably may be renewed. To that end certain specific areas of land customarily are partially or wholly withdrawn from other forms of human use and service to make them available for recreational uses, and are subjected to certain modifications or types of development through which they most fully will contribute to human happiness and satisfaction. Inevitably such action requires certain waivers of opportunity for industrial exploitation of natural resources, and certain outlays of labor, materials, and funds.

Analyses of the social and economic importance of outdoor recreation in the western range States may be facilitated by separate consideration of the recreational needs of the local population and of the residents of the more remote and congested parts of the country.

A natural assumption would be that persons who dwell in intimate association with nature and the elements, as, for example, farmers, miners, cowpunchers, sheep herders, trappers, et al., find in their normal activities all of the inspirational influence of elemental nature

that they desire or need. That assumption is distinctly debatable. Analysis of the early history of the western range States warrants the assumption that the people who first occupied and populated them were attracted in perhaps as great a measure by the spiritual compensations as by the economic rewards. The beauty and interest of their environment was as direct a compensation for the hardships which they suffered as was the monetary return from an exploitation of natural resources. Such intangible renumeration progressively has given way to purely material considerations.

The primitive inspirational quality of much of the western range country has been in large part destroyed. Where once stood beautiful bodies of virgin timber there now are all too often melancholic expanses of stumps, dead snags, and scanty covers of weed trees. Where originally the mind was inspired by views of grass-covered and flower-studded flats and slopes stretching to the horizon it is now depressed by the sight of a terrain scoured and dissected by erosion and only thinly covered by forms of plant life almost entirely devoid of either utility or beauty. In areas once teeming with beaver, deer, elk, bear, antelope, or other game animals, one perhaps may see today only an occasional lone coyote as he tucks his tail between his legs and scurries out of gunshot. Where a great variety of water fowl once dotted the surface of every pond and stream only a few mud hens may today be seen. These transitions have imposed real losses upon the rural dwellers of the western range regions, losses for which the improvements and conveniences of the modern order frequently are only partial compensations. Perhaps many a woman of the western range country gladly would forego some of the mechanical conveniences she now enjoys if in lieu of the bleak prospect now visible from the windows of her home she could regain some of the beauty which remains in her memory of the earlier days.

Through the miraculous growth of its cities, the western range country now has all of the problems presented by large urban populations which need and seek adequate fields for outdoor recreation. The week-end flow and ebb of the tide of nature lovers is one of the striking characteristics of practically every large western city. The relative proximity of large expanses of open country, much of it in public ownership and with widely diversified natural interests, may have stimulated the general tendency to spend leisure time away from the cities, but since the basic conditions of urban life in the West differ but little from those of the eastern cities the needs of the western city dweller for adequate outdoor playgrounds proportionately will be as large and urgent as elsewhere.

But the social importance of the western range States as sources of recreational opportunity is by no means measured by the local population. The airplane, the streamline train, and the motor car now place the most remote parts of the western range in almost intimate geographic relationship to the main concentrations of population. Not only that, these concentrations of population have so overtaxed all locally available opportunities for outdoor recreation that only in the western range States will there be found the detachment and isolation without which certain classes of the population will be unable to enjoy outdoor recreation in its fullest sense. In certain of the Eastern States, with New York the most notable example, efforts

are being made to cherish and safeguard the last remnants of unexploited nature, but the most that can be done along this line will be so pitifully inadequate that in the future the recreational resources of the western range States will have as vital a meaning to dwellers in remote parts of the country as to their own citizens.

Economic Considerations

Economy, in its broad sense, consists of an equitable balancing of the needs and resources of the individual, the community, the Nation, so as permanently to derive from the available resources the maximum attainable satisfaction of needs. Unquestionably people must have adequate spaces in which truly to recreate their minds and bodies by reversion to simple modes of life and close association with elemental natural forces and phenomena, but unquestionably also they must employ in their industrial, commercial, and economic processes the soils and products of soils which are basic to their means of life and cultural advancement, and must so direct the expenditure of their creative labor and capital as to obtain the best net result in human enjoyment and security.

Boundless as the land resources of the United States hitherto have seemed to be, they are after all definitely limited to 1,903,216,640 acres. If each specifically required major type of land use were separately calculated, if one were to total up separately the acreage required for farms, pastures, forests, wildlife refuges, parks, reservoir sites, transportation rights-of-way, towns and cities, etc., the aggregate doubtless would greatly exceed the maximum available acreage. If one were to compute separately the capital and labor required to carry to full fruition the programs of development fixed as the minima for each type of use the combined costs would greatly exceed the maximum amounts that could be made available. Certain adjustments and multiple forms of use of lands and labor are therefore inescapable. That rule applies as fully to the provision of space and facilities for outdoor recreation as it does to any other basic requirement of collective social action.

Then, too, the essentials of outdoor recreation are fixed in large measure by individual interests and inclinations, hence are widely diversified. Some people even in their periods of recreation find no happiness away from the roar and surge of metropolitan life; others can find it only in remote and primitive solitudes. The large numbers of people who by preference spend their summer vacations on farms demonstrate that to many the order and system of a rural community has the strongest recreational appeal. There are even those who derive maximum satisfaction from observing the operations of logging camp and sawmill, or the handling of bands of sheep or herds of cattle. Some will feel that the vacation period is wasted unless they have immediately available every modern convenience and organized form of amusement characteristic of their metropolitan mode of life; to others the proximity of such features is destructive of satisfaction and contentment.

To obtain the necessaries or luxuries of life which it cannot produce within its own limits, the western range country by economic processes of exchange must barter a product or a service of equal

value. In the earliest stage of its occupancy by white man, fur was the only one of its products which met the requirements of transportation and demand. Next in order came the precious metals, also readily transportable even under most difficult conditions and also commanding a world market. Then came realization that grass could be conveyed to a hungry and rapidly expanding market by feeding it to livestock which could be moved on the hoof to points where other transportation was financially practicable. Thus the West laid the foundations for its economic structure by moving into other more settled parts of the world such of its natural resources as the world desired and for which it was prepared to exchange the goods and services which the pioneer West needed but could not in itself produce.

In time a new trend developed. The West contained other natural resources less exportable than fur, gold, silver, and cattle. These were such tangible resources as game animals, birds, and fish; such intangible resources as the inspiring beauty of unmodified nature, the restorative and curative properties of a stimulating climate, the emotional interest of a society founding itself in an environment where all codes and conventions must be evolved under conditions for which no precedents existed. The West thus attracted men from all parts of the globe, who brought with them and freely expended the means or capital with which to maintain themselves or to engage temporarily in appealing activities or pursuits. Thus was the West further enabled to convert its natural resources into permanent forms of economic wealth.

In time, wide networks of iron rails linked the scantily populated West with the more densely populated East where there then existed an ever-rising demand for all products of soil, mine, and forest. In multiplying millions of acres the plow bit into the dense prairie sod, subduing it to the production of grains and vegetables. Shafts and drifts burrowed into the ledges of copper, lead, and zinc. In hundreds of areas of virgin forest the quiet of nature was displaced by the ring of the ax, the crash of falling trees, the rumble of log wagons, and the discord of sawmills. In multiplying numbers there appeared highly competitive industries, with all of the demands made by such industries upon both nature and man. In its more primitive phases mining disturbed but little the peace and beauty of the virgin environment, and in its more intensive phases its influence was localized and relatively of small extent. But between them, grazing, farming, and logging profoundly influenced and modified all parts of the West except where rugged mountain ranges defied invasion by the means then available.

Need now exists to view the economic potentialities of the western range in the light of current conditions and apparent trends. Profound changes have occurred in both standards and priorities of use and value. If it is impossible simultaneously to use a given area for the production of beefsteaks and spiritual stimulation, steps should be initiated promptly to determine which of the two products is more important to the economic future of the region. Frequently it will be found that continued use for the production of beefsteaks not only threatens the ultimate destruction of the resource but currently attracts to the region from other sections a far smaller amount

of money than would be attracted were the resource dedicated to recreational and inspirational forms of use of a practically perpetual character. Frequently it will develop that proper correlation of the two types of use actually is productive of the highest economic return. It is regrettable that decision on these points, not only by landowners and livestock growers but by bankers and public officials as well, so largely has been influenced by past history and precedent and has been so little characterized by analytical determinations of the degree to which any given area will contribute to taxable wealth under one form of use as compared to another, or under a logical correlation of two or more forms of use in proper balance as compared to a single use which to justify itself must be carried beyond safe limits of biological laws.

The economic signficance of the recreational use to the western range States has long been evident. The historic development of the western "dude ranch" is in itself a striking illustration. In practically all such "dude ranches" service to the guest has become the primary function with the actual production of livestock a wholly subordinate purpose. Many a cow town or sheep outfitting point doomed to extinction by the exhaustion of tributary forage resources has found in service to recreational visitors the means not only to maintain but to enlarge its economic foundation. The dollar brought to and left in the region by the tourist seeking only the beauty and interest of nature has just as great a purchasing power and will contribute as fully to the economic existence of the community as will a dollar brought in through the production and sale of beef, mutton, hides, or wool. Furthermore, the tourist dollar need subtract nothing whatever from the sum total of available natural resources, while the livestock dollar inevitably means the subtraction from the soil of at least a minute part of the calcium, potassium, phosphorus, sulphur, or other elements essential to its continued productivity.

The most recent and dependable estimates indicate that the outdoor recreationists of the Nation now expend annually a total of approximately one and three-quarter billions of dollars, with every prospect that the sum will increase with each passing year. Even during the periods of deepest economic depression these dollars flowed from the sections where they were most abundant into the sections in which they spelled the difference between economic life and death. It is true that they were used in the main to purchase oil, gas, tires, motor repairs, food, lodging, supplies, equipment, etc., and that in large part they flowed back to the centers in which such commodities originated, but they also were used to pay for a myriad of local services and privileges and thus in part remained in the area of distribution. To that extent they may be regarded as representing the market value of the recreational resources of the region, for without such resources the local services and privileges would have had no value. No means exist by which accurately to compute the monetary value of the natural resources by which this money was attracted and held in the regions in which it was disbursed, but the fact that the residual receipts permanently retained in local circulation annually aggregate hundreds of millions of dollars seems evident beyond dispute. At any reasonable rate of interest, the part

of the expenditure equitably creditable to the natural resources fixes for such resources a capital value of billions of dollars. Proper conservation of so huge a capital value dictates all reasonable measures and courses of action practicable of adoption.

Adequate conservation of the recreational values demands first of all some modification of past and current processes of natural resource utilization so that they will be constructive rather than destructive. The practicability of the necessary changes is fully demonstrated by experience and precedent. No classes will be more fully benefited by the changes than will the farmers, loggers, and stockgrowers by which they will be made. Industries dependent upon natural resources cannot be permanent and profitable unless the resources are adequately perpetuated and wisely used. But beyond that factor of direct industrial dependence is the general interest of the farmer, the logger, and stockgrower in the welfare and economic strength of the community of which he is a part. If that community is prosperous and has an assured economic future, local markets are good, land and commodity values are high, credit is easy and abundant, and all social, economic, and political institutions are well maintained. Every citizen and property owner shares in its benefits. If the community is faced with a decline in its natural resources, markets are poor, land and commodity values suffer, credit is uncertain and costly, there is a general break-down in all local institutions, and the disintegration of the community destroys the hope and prosperity of all its members.

The Elements of Recreational Value in the Western Range States

The recreational potentiality of western range lands is wholly relative. It may be found in such superlative natural phenomena as the Grand Canyon or Mount Rainier or Yellowstone Valley, or it may reside in a flowing spring surrounded by clumps of aspen which affords the dry farmers in some isolated valley the one readily available area in which to picnic and take their ease. On the basis of proportionate benefit to numbers of persons, certain little canyons and groves which are the natural and nearby recreational areas of small farming communities have a higher social significance than the Grand Canyon or the Giant Forest. The tragedy of past land use in the Western States lies partly in the frequency with which that fact has been overlooked or disregarded. The logging that removed the grove of trees that created the recreational utility of one area, or the grazing that destroyed the ground cover and polluted and caved the banks of the stream that gave beauty and value to another area, or the highway that invaded and destroyed the intimacy with nature in still another area, have not always returned benefits in any measure commensurate with those destroyed. All too frequently large intangible social values have been sacrificed to small material gains because no means existed for relative evaluation or to compel the action most in the public interest.

In outdoor recreation, as in all other human activities, individual tastes and desires are widely diversified. However, it safely may be assumed that if large numbers of people yearly make large expendi-

tures of time, effort, and funds to enjoy certain conditions and qualities of outdoor life and contact with nature, the areas in which such conditions and qualities occur in unusual degree possess recreational values which clearly merit special consideration and treatment. Otherwise such areas could not compete with the other manifold forms of recreational opportunity. This test of successful competition with alternative forms of entertainment and education demonstrates that the western range States possess many and varied forms of natural interest which, properly conserved, would serve as a cornerstone of a permanent economic structure.

The Federal lands hitherto under resident management have been rather thoroughly inventoried and cataloged, so that the parts possessing recreational appeal are now well known and appropriately classified. But the 8 or 10 percent of the national land area popularly referred to as the public domain has been placed under actual management and supervision so recently that there has been no time in which to determine and record the areas of high potential value for public outdoor recreation. However, past observations and reports warrant the belief that in the aggregate the recreational potentialities of the public domain are large and of great social significance. To truly approximate their real future value to the people of the United States there must be consideration and analysis of the types of service and appeal which they actually have rendered and can continue to render if managed with due regard to the importance of such service and appeal.

On first thought it might be assumed that a desert was wholly devoid of any element of recreational utility, yet many people find in a desert an absorbingly interesting and appealing manifestation of certain natural laws, unique types of plant and animal life, evidences of geological evolution, elemental factors influencing the progress of the human race, a tonic climate, a greatly desired absence of modernistic culture, all combining to create in them the highest attainable sense of satisfaction and contentment. But if the desert is dotted with windmills and stock-watering tanks, if its unique flora is unbalanced and its peculiar animal life is forced to change its natural habits by the grazing of domestic livestock, if its brooding silence is shattered by the engines and horns of passing motorcars, and its emptiness is filled with gaudy gasoline stations and billboards, its unusual power to serve certain human needs largely is impaired, with no real assurance that society actually has benefited by the change, or that the new order permanently will contribute as much to the economic security of the local population as would the old order if it were wisely perpetuated.

In the pioneer period, the apparently boundless plains were marked at irregular intervals by water courses whose valleys supported growths of cottonwoods and ash and oak and other indigenous trees, the openings in the forest cover carpeted with lush grasses and flowering plants and shrubs. Dedication of these rich alluvial river bottoms to plow and pasture seemed the logical and desirable course and was the one generally followed. With the passage of the years the alluvial soil all too often scoured to bedrock and the trees all too often yielded to the ax or to fire or overgrazing. If today the people

who crave and need outdoor opportunity could traverse such river valleys without encountering "Posted" or "No trespassing" signs in endless succession; could observe streams which were examples of natural beauty, flowing between grassy banks and through natural timbered areas, free from the pollution of silt and sewage, instead of contaminated trickles of murky, shallow water, shifting with the winds through wide expanses of mud and sand; could find places to camp, picnic, loiter, bathe, and swim free from intrusion, they would regard such areas as social and economic assets of the first order. Where such stream valleys have escaped complete impairment of their natural beauty their preservation against further impairment is dictated by both past experience and future probabilities.

As they penetrated the virgin empire of the West, the pioneers observed, too, knolls, buttes, and chains of hills with sides, and sometimes summits, clothed with trees and shrubs. These lent beauty and interest to the landscape and to the new life taking form within their view. But the trees which covered them could be used to build houses, barns, corrals, and fences, or to heat homes or earn a dollar through their conversion into railroad ties or sawlogs, so they were cut. The grasses and weeds and shrubs which originally adorned the buttes and hills could be used to keep the spark of life in starving cattle or sheep and were so used. Thus what originally were sources of beauty and inspiration to the dwellers of the region all too often became objects of ugliness and devastation. No one can question the action, which was an inevitable consequence of man's struggle to create a new society. But the need for such sacrifices no longer exists, and where, through fortunate accident, such knolls, buttes, and hills have retained their trees and carpets of shrubs, weeds, and grasses, their protection from devastation will save to the American people heritages vital to their future welfare and enjoyment.

These citations of the detrimental effects of past industrial or commercial use of natural resources do not necessarily imply that such use invariably is incompatible with the preservation of the conditions or qualities essential to outdoor recreation. The experience of older countries and of parts of the United States refutes such a premise. Wisely managed, farms add to rather than detract from the attractiveness of their environment, without detriment to profits. Logging conducted under sound principles of forest management does not destroy the charm and inspirational quality of the forest. If governing biological laws are reasonably observed the forage products of fields and ranges can be full utilized without permanent impairment of the vegetative cover. Many a slope and meadow in the Western States, after a quarter or a third of a century of complete utilization under sound principles of range management, is carpeted each season with blooms and blossoms. The situation demands nothing more than the general application to all lands of the western range States of the principles and methods which upon a part of such lands fully have demonstrated their practicability and effectiveness.

The Lesson of the National Parks and National Forests

Federal action during the past quarter century has taken the subject of recreational use of wild lands out of the realm of surmise and theory and has defined its true place in the land economy of the western range States. The results of national-park and national-forest management of lands susceptible to recreational uses are now so clearly apparent that they safely may be used to formulate the principles and procedures which should apply to all planned land use in the Western States.

Dedicated as they are to a single and wholly exclusive type of social service, the national parks exemplify the educational, scientific, and recreational importance of the areas of superlative natural or historic interest and the beneficial economic consequences of a policy which scrupulously preserves them from exploitation. But since they embrace only the areas which are supreme within their classes and completely withdraw such areas from any and all forms of commercial and industrial utilization, the national parks afford precedents applicable to only that very small proportion of the western range country which meets the quality standards prescribed for national and State parks.

Because of their wide geographic distribution, their large area, the wide diversity of forest, land, and geological types which they include, their intimate relationship to the economic life of the regions in which they are situated, and their primarily utilitarian purposes and objectives of management, the national forests provide a broader and more generally applicable demonstration of the place and part of outdoor recreation in the economy of the western range States, and of the principles and procedures through which it can be correlated with other associated uses of the same general areas so as most effectively to realize its social and economic values and at the same time permit a reasonable continuation of other types of industrial and commercial utilization of lands and natural resources. This fact justifies a somewhat detailed analysis of the past history of the recreational use of the national forests, its beneficial and detrimental aspects, its growth, and the means by which it has been harmonized with the basic objectives and administrative requirements of national-forest management.

By their very nature the lands reserved for national-forest purposes are rich in all the elements of natural interest sought by lovers of the out of doors. Great expanses of forest, towering peaks, deeply dissected canyons, innumerable lakes, streams cascading over falls or rippling through pleasant valleys, grass-carpeted glades or openings, game animals, birds, and fish, fruits and flowers, unique geological formations, and other interesting phenomena offer to visitors almost endless opportunity for educational and entertaining activities. Long before the forests were created the lands now within their borders largely were used by the local residents for recreational purposes. To the settler devoting all of his energies and funds to the conversion of a quarter section of tough prairie sod into a productive farm, and to his family, the seasonal trips to the mountains were for fun as well as fuel. To the residents of the raw little towns in the valleys the timbered hills offered beauty

and peace and freedom as an antidote to the monotony of the daily routine. The miners found in the silence and natural charm of the forests relief from the turmoil and labor of the mining camp. Simple structures for summer occupancy, sometimes isolated, sometimes in small groups or colonies, afforded many families deeply cherished opportunity to escape the heat and dust of their habitual environment. Present recreational use of the national forests is the natural evolution of a social trend which was well defined at the time the forests were established.

In time, new factors gave the recreational potentialities of the forests far more than a local significance. The practicable development of the automobile endowed many families with a new mobility, which progressively expanded with the extension of the public highway system. The more general establishment of holiday and vacation periods largely increased the leisure time available for travel. The dim blue line of mountains vaguely marking the horizon became to the dwellers of the valleys a readily accessible outdoor playground of which they were quick to take full advantage.

The consequence of this change is shown graphically in figure 78. In 1917, when the Forest Service initiated the first systematic estimate of the numbers of visitors, the total was 3,160,000. In 1934 it was 38,063,098, or twelvefold. It is, of course, true that these figures contain many duplications and do not represent the exact number of persons who made use of or passed through the national forests, since the individual who visited the same forest on several different occasions, or who visited several different forests in succession, undoubtedly was counted several times. But notwithstanding their imperfections the estimates do reflect the trends and changes in the volume of public recreational use of the national forests and are supported by the physical evidences of such increased use which are manifest to any observer.

In the earlier stages of this development the forest officers regarded it with grave concern and some antagonism. It markedly increased the hazards of fire and of water pollution, deprived range livestock of access to indispensable sources of water supply, conflicted with logging operations and imposed heavy additional administrative burdens. The summer-home communities, all too often poorly planned, constructed, and maintained, marred with their ugliness the natural charm of the forest, lake, or valley. The logical course appeared to be the limitation and eventual elimination of forms of use so evidently inconsistent with the primary purposes and functions of the national forests.

But as time passed appreciation developed of the tremendous social and economic significance of this public recreational use. To multiplying millions it afforded opportunities for healthful stimulation of body, mind, character, and citizenship not readily available through other means. To the regions embracing the forests it brought new sources of income, new markets for local products and services, which otherwise would not exist. To the foresters it provided opportunity to demonstrate the real nature and meaning of forest conservation and its true relationship to both individual and national welfare. With this altered perspective, the visitors themselves, the local residents, the local officials, and the foresters engaged with a new interest in the development of ways and means whereby

this new use of the public properties could be reconciled with their other traditional and essential uses and thus be enlarged in both volume and public value.

The most obvious and urgent requirement was adequately to protect public property from destruction by fire, and public health from the menace of water-borne diseases. So long as millions of persons distributed themselves indiscriminately throughout the bodies of timber and upon the watersheds of municipalities the situation was fraught with danger. The most logical approach was to induce voluntary concentrations of the summer visitors at points where the

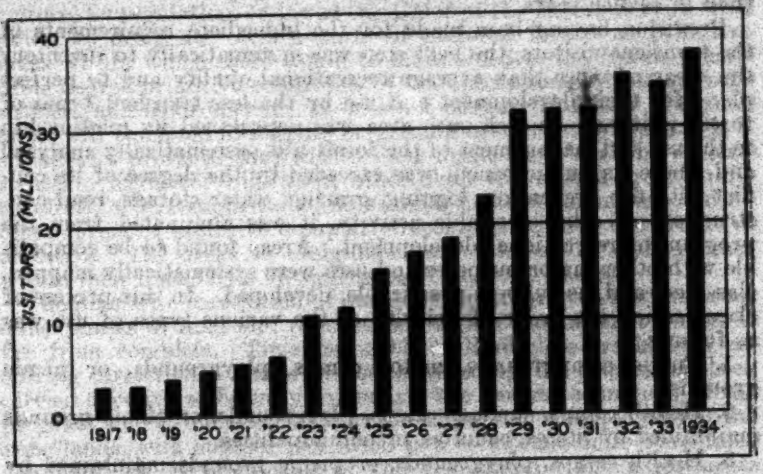

FIGURE 78.—THE PROGRESS OF RECREATION ON FOREST RANGE.

From small beginnings the annual influx of visitors on the national forests has assumed huge proportions and is growing. Numbers have more than trebled in the last 10 years.

risk to public property and health could be reduced to a minimum by the provisions of proper facilities and by the opportunity for more continuous supervision and control. To this end, series of free public campgrounds were established in each national forest and as rapidly as available funds permitted were developed with simple facilities for sanitation, garbage disposal, control of fire, and forms of recreation by which the visitors would be attracted to and held upon the campgrounds instead of diffusing themselves widely throughout the forests. At present, approximately 4,200 areas within the national forests are now designated as public campgrounds and of these 3,016 areas have now been equipped with at least a part of the utilities and facilities essential to their proper public use. In this work the Civilian Conservation Corps has been of inestimable value and additionally a great deal was accomplished with relief labor under the several emergency-relief programs. These campgrounds are not as a rule pretentious or provided with more than the bare essentials but by their convenience and comfort they draw and hold all but a negligible minority of the recreationists and thus have greatly reduced the dangers to public property and health which otherwise would occur.

There have been frequent allegations that as the extension of the forest highway and forest development road gave public access to additional areas of forest land there would be abnormal increases in the numbers of destructive fires so that the net effect would be detrimental rather than beneficial. Experience has not supported this theory. The road which gives the public access to new areas of possible fire risk also permits the prompt attack of such fires as occur so that they are extinguished before they attain serious proportions. The ratio between the number of fires caused by summer visitors and the total number of summer visitors is now smaller than in earlier years.

Provision having been made for the immediate requirements of the transient visitors, the next step was systematically to inventory the areas of more than average recreational quality and to perfect plans for their development and use by the less transient types of forest visitors. As each such area was determined its relationship to the use and management of the forest was systematically analyzed and where its public benefit was exceeded by the degree of its conflict with fire prevention, logging, grazing, water storage, road construction, or other desirable activity, it was eliminated from the program of recreational development. Areas found to be compatible with other major purposes and uses were systematically mapped, classified, and, as fully as practicable, developed. In this process of classification the order of priority of the various types of use was as follows:

1. Public campgrounds, motor camps, playgrounds, or picnic grounds.
2. Health camps, summer camps, playgrounds, or picnic grounds maintained by States, counties, or municipalities.
3. Health camps, playgrounds, or picnic grounds maintained by semipublic organizations.
4. Health camps, summer camps, playgrounds, or picnic grounds maintained by charitable, fraternal, denominational, or other like organizations.
5. Summer schools conducted by public agencies.
6. Hotels, camps, and resorts operated on a commercial basis for the accommodation of the general public.
7. Public utilities, such as stores, garages, filling stations, boathouses, liveries, etc., for which there is an actual public demand and need.
8. Clubhouses, camps, resorts, and campgrounds maintained by private organizations for the exclusive use of their membership and not available to the general public.
9. Summer homes for the exclusive use of permittees and their families.

Adherence to this principle of giving preference to the type of use productive of the largest social benefit has prevented individual monopolization of key national-forest areas and has resulted in balanced types of development and use. While there are numerous isolated cases, the greater proportions of the 12,783 summer homes and the 977 hotels, resorts, and outdoor camps now under permit on

the national forests have been fitted in to a planned pattern of land use through which each separate area is dedicated to the highest practicable form of service.

With the so-called Bankhead bill of 1916, Congress began to make increasing provision for highway and road construction within the national forests, thus opening to motor travel numerous large areas previously accessible only to horsemen or hikers. Many sincere students and lovers of nature saw in this trend a threat to all areas still in the primitive condition characteristic of the pioneer stages of the Nation's history. To allay these fears the Secretary of Agriculture, by regulation, endowed the Chief of the Forest Service with power to designate certain parts of national forests as primitive areas within which there would be maintained to the fullest practicable degree primitive conditions of transportation, habitation, subsistence, and environment. It does not necessarily follow that such areas will be closed to logging or grazing or water storage, but it is specifically provided that within their limits there shall be no construction of motor highways, other than the simple truck trails required for fire suppression, no summer-home communities, and no other forms of exclusive occupancy incompatible with the primitive objective. The areas so designated now number 71 and embrace within their boundaries an aggregate of 11,378,411 acres.

The plan-wise correlation of outdoor recreation with the numerous other phases of land and resource use within the national forests is far from complete. Time inevitably will disclose weaknesses requiring correction. That fact notwithstanding, the process has been carried forward sufficiently to confirm the general soundness of the program, and to demonstrate that the concept of multiple uses of the same lands, with outdoor recreation as a coordinate or in some cases dominant use, is practicable of full realization. The adjustments in methods of utilization and management needed to give complete reality to the concept are all well within the practical limits of industrial management and administrative organization. That they will pay for themselves in permanence of resource, economic security, community prosperity and individual health, happiness, and contentment, seems now established beyond the possibility of successful refutation.

Constructive development of the recreational resources of the western range lands can be credited to private initiative in only rather limited degree. The greater part of what has been accomplished to date is the work of public agencies as a feature of their management of public properties. Private management of range lands usually is motivated by rather narrow industrial objectives, but in the management of publicly owned lands the appropriate objective is the realization of all forms of service and use in the fullest necessary and attainable measure. Recognition of the limitations of private action in the conservation of recreational resources is concomitant recognition of the necessity for public action to conserve and adequately develop the recreational resources on the publicly owned lands.

Future Requirements

Adequate recognition of the social and economic advisability of shaping the future land use of the western range States so that the potentialities for outdoor recreation with which such States are so richly endowed will not be impaired to the detriment of the present and future generations.

Comprehensive studies of the true economic significance of outdoor recreational use of lands, its real part in maintaining and enlarging the industrial and commercial life and general economy of a given region; with appropriate comparative studies of the volume and permanency of the returns obtainable from other uses of the same land incompatible with or destructive of recreational uses.

Systematic analyses of the elements of natural interest, scenic beauty, wildlife, stimulating climate, and educational appeal which are sought and desired by the lover of the out-of-doors; classification of all areas embodying such elements in abnormal degree; and adoption of principles and plans of use and management through which recreational use of such areas effectively can be correlated with other desirable forms of use.

AS AN INTEGRATED PART OF WESTERN AGRICULTURE

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INTRODUCTION

The use of native forage by domestic livestock in the West probably began in 1598 when Don Juan de Onate brought 7,000 cattle and probably some sheep and established colonies on the Rio Grande River in north central New Mexico. Continuous use, however, did not begin until about 1692 when DeVargas reconquered the Indians who had rebelled and driven the white men out of the country. Then for a century and a half numerous little villages basked peacefully in the southwestern sunlight along the Rio Grande, their inhabitants content with the living derived from irrigated fields and the cattle and sheep which grazed the surrounding hills. By the early part of the eighteenth century a number of large and prosperous haciendas had developed in the Southwest, dependent on mining, cattle, and farming. Some of these haciendas grazed large numbers of cattle. The San Bernardino, which was about 17 miles east of the present town of Douglas, Ariz., once ran 100,000 head of cattle, 10,000 horses, and 5,000 mules (*70*).

Another section of this report has told how, from its beginning in the Southwest, California, Texas, and the mining camps, livestock quickly occupied the entire range country. This industry was at first almost wholly pastoral. Based upon the sole use of native forage, it was naturally transitory in character and subject to many vicissitudes.

But even during these early days of the vast range livestock industry, crop farming began to appear here and there throughout the West and before long to ally itself closely with stock raising. Disappointed gold seekers began to farm in the great valley of California in the early fifties. The Mormons in Salt Lake Valley began to grow lucerne and other crops on irrigated tracts about the same time. Even while the cowboy—that picturesque figure of the West—sang his "lament" to the herd on the Chisholm Trail, the breaking plows turned under ever-increasing acreages of lush grass sod on the prairies. Daniel Freeman patented the first homestead near Beatrice, Nebr., in 1869. In the seventies ranchers began to cut native hay on the Platte and Arkansas Rivers in Colorado, first to supply Army posts, and later for winter feeding of range livestock. Soon visionaries were dreaming of the Roosevelt and Pathfinder Dams, the Boise, Minidoka, and other reclamation projects.

Thus crop farming was developing within the same territory and upon land first used for grazing. By 1900 there were 242,908 farm units in the 11 western range States with 93,797,000 acres [41] of land in farms; in 1910 there were 378,337 farm units and 110,862,000 acres

[41] These acreages include all land in farms regardless of ownership (i. e., private, State, county, and Indian lands).

of land in farms. The first big irrigation dam—the Shoshone—was completed in 1910, the Roosevelt in 1911, and others followed.

Western agriculture became more and more diversified. Specialty crops, largely independent of the use of range forage, such as fruits, nuts, cotton, and vegetables were grown, mostly on irrigated lands.

In great part, however, crop farming was dependent on range use by domestic livestock. In some places use of the range by livestock developed coincidentally with the growing of grains, forage, and other crops. Meat packing and processing plants were established over the West and the fattening and finishing of range steers and lambs with western-grown feeds began and grew. Many of those engaged in crop farming also grazed domestic livestock on the range and thus more and more people became dependent in part upon grazing. By 1930 there were 775,748 farm units and 392,159,936 acres of land in farms in the entire range country, and the texture of western agriculture had become in great part an interwoven complex of interdependent crop farming and grazing of range land.

The Magnitude of Western Agriculture

A substantial part of the total wealth of the West comes from its agricultural development. In contrast with the Middle West, this development has not been easy. In the Middle West, as a result of ample precipitation, the lands were in large part ready for cropping when the settlers arrived. All that was necessary was the breaking up of the virgin sod, the planting of the seed, and the cultivation and harvesting of the crop. The semiarid conditions of the West, however, imposed a much heavier burden. Irrigation developments, usually at a heavy cost per acre served, had to be completed before the land was ready for tillage and the raising of cultivated crops.

Huge expenditures by the Federal Government, the States, and private enterprise have been made for the development of irrigation, roads, range improvements, and other construction projects. Additional expenditures have been made in developing new species or strains of fruits, vegetables, grains, forage, and livestock adapted to western conditions; in the prevention and control of insect pests and disease scourges; in financial loans, and in other ways, to improve and give stability and permanence to western agriculture.

Farm lands, buildings, machinery, and farm and range livestock form a substantial part of the wealth taxed for the support of State and local governments, educational and other institutions, and improvements. These lands, buildings, and machinery in the range region in 1930 (1930 census) were valued at 11.5 billion dollars, or 22 percent of the comparable total for the United States. The number of livestock was 63,092,000 valued at 1.4 billion dollars.

Domestic production of wool and mohair is primarily in the range territory. In 1930 the production of these commodities was 276,217,000 pounds, with a value of about $82,134,000 (75 percent of the 366,317,000 pounds valued at $113,317,000 produced in this country).

The full importance of any business to a community is not, however, expressed by statements of values in dollars. It is the flow of money in a community which supports the stores, the banks, the churches, the schools, and in fact the whole community existence.

That the direct value of crop products from the range States was $1,600,354,000 and of livestock was $476,185,000 in 1930 only partly expresses its magnitude. It is even more significant when expressed in the standard of living of about two million American families, plus the contribution which is made to all of the business enterprises which serve the agricultural undertaking. It hardly need be said that the agriculture of the West affects local, national, and world trade and penetrates into the whole social and economic fabric.

Diverse Patterns of Western Agriculture

The range country encompasses wide expanses of plains, plateaus, mountains, and lowlands, with almost every degree of intermixture and arrangement. Within such an area there are many conditions of soil, of rain and snowfall, of temperatures, and of vegetation. In general, however, it is semiarid country with crop farming on scattered irregular areas of widely different sizes and condition—fertile irrigated and subirrigated tracts in the valleys along the base of the mountains, or on the plains where water is available; supermarginal and submarginal dry farms sometimes in large blocks, sometimes dotted here and there with no apparent semblance of order; native hay lands in the mountain meadows, along the mountain valleys—and on the plains; and enveloping all of these are the range lands.

Over such a large area, and under such a wide variety of influencing conditions the patterns are many and varied, but they fall into two general forms, specialized crop farming and combined crop farming and range livestock grazing.

SPECIALIZED CROP FARMING

Specialized crop farming is devoted primarily to the production of fruits, nuts, vegetables, and other specialty crops. For the most part, it is conducted on very high value fertile lands, where adequate water is obtainable for irrigation. This type of agriculture devotes suitable land to its highest use and is of great economic importance. In general, however, it has but indirect relationship to the use of range-land forage.

CROP FARMING AND RANGE LIVESTOCK GRAZING

Variations in the association of crop farming for other than specialty produce and range livestock operations are innumerable. At one extreme is the wheat and cotton farmer, whose operation may be but indirectly related to range use. At the other is the yearlong livestock operation, to which little or no cropland is attached. In between these extremes is a great number of combinations of farming and range livestock operations. Here cultivated crops furnish the main cash income with sometimes the livestock grower as the only available marketing opportunity. There livestock raising is the major business, with farming merely to produce the necessary supplemental feed. Elsewhere the harvested croplands and even the vineyards and orchards furnish forage. And again a hay producer depends on the stock owned by his neighbors to furnish a market for his product. Thus the farms and the ranges of the West, whether they be in Arizona, Utah, Montana,

California, or Washington, are so interdependent one with the other that to think of either separately is impossible. While no attempt can be made to list all combinations, it is feasible to distinguish the following distinctive types:

1. Consisting entirely of range lands used for livestock production—all supplemental or fattening feeds purchased.
2. Consisting of range land used for livestock production and of limited areas of crop land used for raising small amounts of supplemental feed for saddle and work animals. Additional supplemental feed purchased.
3. Range lands used for livestock grazing with crop farming sufficient only to provide supplemental feed.
4. Innumerable variation of range lands used for livestock production and crop lands used for cash crops, and to provide supplemental feed for range livestock.
5. Various combinations of range livestock and crop farming, together with other part-time occupations as, for example, "dude" ranching.
6. Dairy farming. Use of range confined to summer pasturage for dry cows and heifers.
7. Crop farming entirely, with milk and work stock using adjacent range.
8. No range use—crop farming for the production of grain or other cash crop. The only direct dependence on the range is sales of supplemental feed and plowed and irrigated pastures for use by range livestock.

SIZE OF FARM AND RANCH OPERATIONS

Within the types described there is an equally great variation in the size of outfits. They may have as few as 5 to 10 head of cattle or sheep or as many as 60,000 cattle, and 80,000 sheep, or more. Acreages of land controlled may vary from as little as 10 acres of farm land to 400,000 or 500,000 acres of range land with some farm land. There are some limited instances of probably 1,000,000 acres in a single ranching operation.

PRODUCTS OF FARM AND RANGE OPERATIONS

The products of western agriculture consist in part of the things that grow from the soil and in part of the animals which feed on them. Grain crops and other products, chiefly livestock feeds, are produced on the cultivated areas and are in large measure consumed by the ultimate marketable product—livestock. The other major product, the range forage, often determines whether or not a well-rounded and profitable agricultural business results. Thus the products of the farm and of the range are so thoroughly integrated in the economic structure of the western agriculture that they are in truth inseparable.

Livestock and Livestock Products

Some idea of the extent to which range livestock contributes to the possible prosperity of western agriculture can be obtained from the following figures:

The estimated present numbers of livestock other than milk cows and swine in the 17 range States are 18,737,000 cattle, 32,407,000 sheep, 3,531,000 horses, 531,000 mules, and 4,664,000 goats. In addition, there are estimated to be 3,509,000 milk cows, and 4,714,000 swine. Use of the range by both milk cows and swine is, however, of minor consideration.

Range forage is used chiefly by meat cattle, sheep, horses, and goats. The usual range livestock operations graze either cattle or sheep, but combinations of two or three classes of stock are not uncommon. Few ranches graze horses exclusively.

Livestock products vary with the suitability of the range and crops to produce certain classes of meat animals, and with trade demands. Changes in livestock breeds and in type of animal produced are often made to meet changes in public fancy for meats of different classes or to meet trade demands for various grades of wools. While there are infinite variations over such a large territory as the range States, ranching operations from the standpoint of products may be placed in several major groups.

1. *Feeders and stockers.*—Feeders and stockers are the major products of most cattle ranches. They are sold by producers either as feeders for finishing as fat cattle on grain, crop forage, or feed concentrates, or for further conditioning on crop-land roughage in winter, or on grass pasture during the spring, summer, and fall. Large numbers of feeder steers are sold as "long yearlings", or about 15 to 18 months old. Feeders and stockers include steers, heifers, cows, and bulls (*171*).

2. *Grass-fat cattle.*—Many ranches having an abundance of summer forage turn off in the fall cattle that are in condition to slaughter. Large numbers of steers, dry cows, heifers, and bulls are sold in grass-fat condition. Grass-fat stock, particularly steers, are often subject to competition between packers for immediate slaughter and feeders for finishing.

3. *Aged steers.*—Three and 4-year-old steers are still grown on some ranches. Production has decreased over the years, however, as exports markets for heavy beef have decreased, and as domestic fancy for beef has turned more to lighter cuts. Especially good range forage is required to produce this class of stock in acceptable flesh.

4. *Calves.*—Public fancy for light cuts of meat and young beef has turned many ranches to the marketing of calves at weaning age. Large numbers of these calves are fattened and marketed as "baby beef."

5. *Feeder and mutton lambs.*—Sheep growers produce both feeder and mutton lambs. The lambs which reach the market in middle and later summer or early fall are sold either as feeders or fat lambs for immediate butcher, depending largely on their condition. Also many lambs are sold directly as feeders to operators who fatten them for later marketing. The late summer and fall runs of range sheep fall in this class. Old ewes are also fattened for mature mutton.

6. *Spring lambs.*—Many sheep growers produce spring lambs which are marketed during the slack spring period after the heavy sales of winter-fed lambs and before the heavy summer sales of fat

lambs. The earliest of these, known as "Easter" or "hot-house" lambs, are produced mainly in Arizona and California by supplemental feeding of mother ewes on cropland forage and concentrates, and by use of irrigated pasture during the winter period. Idaho, California, Oregon, and Washington produce large numbers of "milk fat" lambs which are marketed during the spring and early summer soon after the early runs of "Easter" lambs.

7. *Fat cattle and lamb finishing.*—Feeding and finishing of cattle for slaughter has increased in the range States with the increase in crop farming and with the increased production of corn and other grains, alfalfa and other hay, and feed concentrates. For example, on January 1 of the last year for which figures are available, there were estimated to be 402,000 head of cattle and 1,560,000 lambs on the feed lots in the 11 western range States. Lambs, however, are often fed and shipped to market as fast as they are put in condition, and then replaced, so that the number on feed on any one date does not indicate the total number marketed during a season. Feeding operations are conducted by (1) operators who produce the feeders and purchase feed from crop farmers and others, (2) feeder producers, who grow their own grain and hay, (3) crop farmers who purchase feeder cattle for fattening, (4) contract feeding under various systems, (5) and independent operators who buy both stock and feed.

8. *Dairy stock.*—Many dairy farmers throughout the West depend on the range for pasturage for dry cows and young heifers being held for replacement of aged cows.

9. *Purebred livestock.*—Purebred livestock are raised to some extent throughout the West, for local and interregional markets.

10. *Wool and mohair.*—Wool is a major product of all sheep-raising and mohair of goat-raising operations. Wool varies in quality from the fine wools of the Merino and Rambouillet breeds to the medium and coarse wools of the mutton breeds of sheep.

11. *Saddle and light work horses.*—These are raised usually in connection with cattle operations. With the mechanization of farming there was small demand for horses, but during the past few years, with returning use of horses, sales have been good and have been an important source of income to many farmers and ranchers in the range States.

12. *Hides and pelts.*—These are a product of all cattle and sheep operations.

Cropland Products

Crops grown by farmers and ranchers vary widely depending on soil types, climate, irrigation, needs for diversification of products, and requirements for supplemental forage and fattening feeds. The wide variety and combinations of crops produced precludes any attempt at detailed classification; there are, however, some general types which may be recognized:

1. *Native hay usually with limited corn or small grains.*—In many cases such crops are used almost exclusively for supplemental feeding of range livestock either as a part of a combined crop-farming and grazing operation, or by livestock operations which purchase supplemental feed.

2. *Native hay and alfalfa, limited corn or small grains.*—Such crops are often used primarily for feed in connection with a combined crop-farming and livestock operation. They may, however, be in part used and in part sold as cash crops, with innumerable variations according to the operating set-up of different "outfits."

3. *Wheat farming, with limited other small grains.*—Wheat farming in the main is for the production of a cash crop but other crops are usually grown also, which, together with stubblefields and forage byproducts, furnish feed for livestock.

4. *Combination crops of alfalfa, grain, sugar beets, potatoes, and truck.*—Alfalfa, beet pulp, and grain straw furnish suppplemental and fattening feeds for livestock. They may be used by the producer for feeding stock raised by him or sold to livestock operators.

5. *Corn, beans, and sorghums, grown primarily for feed.*—Dry-land farming may be limited to a small variety of crops which are used primarily as supplemental feed for range livestock.

6. *Cotton, wheat, and sorghums.*—Crop production in parts of Oklahoma and Texas consists chiefly of various combinations of cotton, wheat, and sorghum crops. The cottonseed concentrates and sorghums are used as feed for livestock, either as part of a combination farming and livestock operation or for sale to livestock grazers. Cotton is also grown under irrigation in Arizona, California, and New Mexico.

Thus the feeder steers, the baby beeves, the feeder lambs, the finished cattle, and other livestock usually depend for salability in greater or less degree upon the hay, the grain, the sugar beets, the corn, and the sorghum produced on the crop lands. Too often without the farm the range would be unprofitable and without the range there would be no market for the products of the farm.

SEASONAL USE

Just as there is great diversity in the type and size of the operation and in the kind and method of marketing the products grown, so also there is a wide variety in the customs and requirements for seasonal use of the range. That this should be true, naturally follows from the great spread in climate, topography, and vegetative types included in the range country.

Range lands are grazed for different periods, from 3 or 4 months in summer to the full year. Seasonal-use ranges are usually placed in four major classes—spring and fall, winter, spring-fall-winter, and summer (fig. 79).

The use of spring, summer, and fall ranges is governed primarily by altitudinal variations and general climatic conditions. Yearlong use is confined to areas where winter climate is mild, and to types of forage which cure well on the stalk and provide nutritious dry feed. Large areas, however, adapted by climate and forage to yearlong grazing, are used only during the winter season, because of their proximity to summer range in the mountains, or to crop lands where they are used in connection with supplemental feeding of forage crops, and irrigated pasture. Other areas otherwise suited to yearlong use, because of absence of permanent water, may be grazed only during periods when temporary water from rain or snow

is available. Use of some ranges upon which the forage consists of annual species which dry up during the summer months, are confined to fall, winter, and spring grazing.

There are, within wide latitudes, several general characteristics of seasonal use by ranching operations.

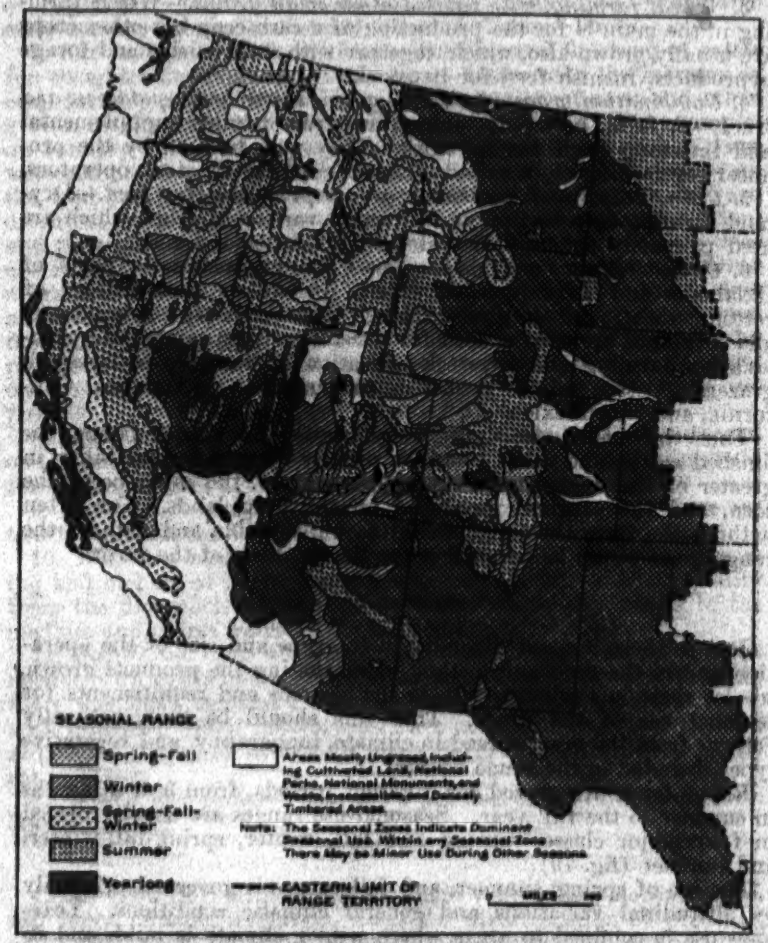
SEASONAL RANGE
Spring-Fall
Winter
Spring-Fall-Winter
Summer
Yearlong
Areas Mostly Ungrazed, Including Cultivated Land, National Parks, National Monuments, and Woods, Inaccessible, and Densely Timbered Areas.
Note: The Seasonal Zones Indicate Dominant Seasonal Use. Within any Seasonal Zone There May be Minor Use During Other Seasons.
EASTERN LIMIT OF RANGE TERRITORY
MILES

FIGURE 79.—SEASONAL-USE AREAS.

In the mountain regions the shortage of range for spring-fall use presents a serious problem, particularly as deterioration is greatest on this class of range.

1. *Use of one range unit throughout year.*—Such use is confined to areas where climatic conditions are favorable, and forage species furnish nutritious dry feed after the growing season.

2. *Use of range all year with removal from low areas in winter to high areas in summer.*—Sheep are sometimes trailed or shipped

200 miles or more twice during the year between summer and winter range; cattle are usually moved but short distances.

3. *Use of range in spring, summer, and fall with short winter-feeding season on products from crop farming.*—Many small and moderate-sized operations winter-feed on crop forage for varying periods.

4. *Long period.*—This consists of 7 to 10 months on summer range and 2 to 5 months winter-feeding period, with some continual use of range except for storm periods or deep snow. Prevalence of severe winters in some parts of the West preclude winter grazing except to a limited degree, and stock are fed during the winter season. This is practicable only where forage crops and hay, usually produced wholly or in part on crop and hay lands operated by the livestock concern, provide reasonably priced supplemental feed.

5. *Rotation between cropland pasturage and range at various seasons.*—Owned or leased stubble fields and cutover hay lands are used by many operators in late fall for periods of 2 weeks to a month or more, also after stock are removed from the range and before winter feeding begins. Winter wheat in some sections is grazed for varying periods in late fall and early winter. In California particularly, cropland and irrigated pasturage are used during the summer period when range feed dries up.

Thus the seasonal use of the range varies all the way from year-long continual use to a short period during the summer. The character and availability of farm-grown forage and supplements, the character of the range, and the climate, all enter into the determination of the grazing season for any given locality.

LAND TENURE AND CONTROL

In no phase of western agriculture is there wider diversity than in that of land tenure and control. This varies from the tramp stockman who owns no land and leases little for his precarious but often profitable operation, to the substantial operator who owns the farms, ranches, and ranges on which his stock graze throughout the year. In between there are many combinations of ownership, leases, permits, and unauthorized use. Primary factors which influence tenure and control are (1) the variegated pattern of land ownership in the West, (2) purchase prices and leasing costs of land as compared with its productivity values, (3) the methods of handling stock on the range, (4) forms of Federal reservation of public lands, (5) the extent of unreserved public domain usable as free commons, and (6), in part, the purposes of land occupation since the beginning of settlement. A few important general types of land tenure and control require definition.

Range Land

1. *All owned by ranching operation.*—There are comparatively few livestock operators who own in fee simple all of the range land required by the outfit.

2. *Owned and leased in varying proportions.*—Use of leased land in connection with varying proportions of owned land is a very common system of range tenure throughout the West.

3. *National-forest range.*—Many range livestock operators, large and small, are entirely dependent on feed grown on owned crop land and forage on the national forests.

4. *Owned or leased land, public domain, and other publicly owned ranges.*—The most common type of outfit owns some farm and some range lands, leases a varying acreage of both from private parties, uses the unreserved public domain for certain seasons, and utilizes national forests, Indian reservations, or State land under permit or lease, as the case may be, for the remainder. Normally the national forests provide high range required for the summer season.

5. *No owned range.*—Many livestock concerns operate entirely on leased range lands or with varying acreage of leased range used in connection with unreserved public domain and other free range.

6. *The tramp sheepman.*—This class of sheepmen, who controls no range nor owns a ranch, is disappearing.

The fact that the right or the privilege of occupancy of range land is held by various methods does not in innumerable instances insure the grazier control of his areas to the exclusion of others. Many ranges are used in common by a number of concerns who individually own or lease widely scattered and intermingled parcels of land, among which may also be included unreserved public domain or other free range. Individual control of such ranges for purposes of good land management and husbandry is impracticable. In other cases owned and leased lands may be strategically located to control watering places or ingress or egress to grazing areas in such a manner as to give virtual control on the range unit.

Cropland

Much crop land used by livestock concerns is owned, but large acreages of irrigated pasturages and some crop-producing areas are leased.

REGIONAL CHARACTERISTICS OF CROP- AND RANGE-LAND AGRICULTURE

In the development of the West, partly as a result of precedents which came with settlement, partly as a result of wide differences in market possibilities for the products raised, and partly as a result of differences in such controlling features as climate, topography, and the availability of water for irrigation, rather distinctive regional differences have been built up. Although sharp dividing lines cannot be drawn and the characteristics of one region may gradually merge with those of another, the major differences justify the recognition of four broad regions.

PLAINS REGION

The Plains region as used here includes the range area east of the Rockies and north from southern Colorado and the Oklahoma Panhandle to Canada. This region is well adapted to a highly interdependent crop farming and range agriculture. The remaining range areas of the tall-grass prairies and most of the short-grass plains are within this region. The range lands in general support

a good growth of nutritious forage, used in close relationship with a large amount of dry-land crop farming and some irrigation, particularly along the North and South Platte and Arkansas Rivers and in Montana. Grains, sorghums, corn, sugar beets, alfalfa, and other crops, together with native hay, furnish large quantities of supplemental and fattening feeds. The area around Greeley, Colo., for example, is one of the important lamb-feeding sections of the West.

Livestock are grazed for the most part during a long summer season varying from 7 to as much as 10 months, and in some instances yearlong. The prevalence of severe winters and at times intense blizzards and drifting snow requires winter feeding of supplemental crop forage. Because of the high productivity of these ranges in general, they turn off large numbers of grass-fat cattle as well as feeders.

In spite of naturally favorable conditions for integrated agriculture, this region, with some notable exceptions, presents major range problems. The relatively level to rolling topography led to widespread homesteading and to attempts to grow wheat on land which is now known to be submarginal for such use. Because of this submarginal farming much of the region is characterized by a high percentage of abandoned farms and deserted homes. Furthermore, the land ownership pattern is complex and confusing, owing to remnants of State land, tax-reverted county land, mortgage-foreclosed land in the hands of insurance companies and financial agencies, railroad grants, and a large percent of nonresident-owned private land as a result of speculation. Generally, owned land forms a high percentage of the operating acreage of ranching concerns.

Some outfits lying along the eastern front of the Rockies use national-forest range. The regional characteristics are reflected in ranch organization.

A group of 77 ranches studied in North Dakota, South Dakota, Montana, and Wyoming run an average of about 300 head of cattle and control by ownership and lease an average of 5,692 acres of land (*187*). More than half of the ranches made some use of national-forest or public-domain ranges. The average total area owned and leased was divided up as follows:

	Acres
Owned crop land (6 percent)	344
Leased crop land (0.6 percent)	34
Owned grazing land (48 percent)	2,746
Leased grazing land (45 percent)	2,568

Studies in eastern Colorado (*85*) toward the southern portion of the Plains region show a trend toward larger outfits, less crop land, and more leased grazing acreage. Twenty-two ranches, running usually a little over 1,000 head of cattle, had an average controlled area of 19,071 acres, as follows:

	Acres
Owned crop land (1 percent)	187
Owned grazing land (32 percent)	6,092
Leased grazing land (67 percent)	12,792

SOUTHWEST REGION

The Southwest, including Arizona, New Mexico, and the range country of Texas, embraces large areas of low-lying desert and semidesert, broad plateaus, and comparatively few isolated mountain ranges.

Climatic conditions and forage types are favorable to yearlong use of the range. Dry-land crop farming is limited to scattered areas varying greatly in size and in general is very uncertain. There are some irrigated areas along the base of the mountains and in the mountain valleys and several large reclamation projects.

Because of this lack of well-distributed crop farming, livestock concerns are highly dependent on the range-forage resource. Crop farming by range-livestock outfits, except in a few favored localities, is extremely limited, and supplemental feed is purchased, usually at expensive figures, when necessary to meet shortages of range forage.

The low forage productivity of the range and lack of diversification result in many large livestock concerns, both in numbers of livestock and range areas controlled.

The cost per animal unit of range improvements for control and management is high. Lack of adequate natural stock water over much of the range necessitates costly water development.

The low grazing capacity, dry-feed ranges produce chiefly feeder cattle and feeder lambs. In Arizona, however, the irrigated crop farming and pasturage on the Salt River Valley projects enable some sheep growers to produce early milk-fat "Easter" lambs.

Acreage prices of land, grazing capacity considered, are high, and there is a high proportion of tenure by lease. In Texas 82 percent of the land is privately owned, often in large blocks, and 18 percent is State owned. As a result, ranching operations in Texas show a high proportion of owned land in rather compact units of management.

Also in the northern portion of the Texas range area there is considerable crop farming. Wheat, grain, sorghums, and cottonseed concentrates provide supplemental feed for use in connection with livestock grazing.

Studies of ranch organization show the means of land tenure, the acreage relationship of crop and grazing land, and size of outfits for different groups of ranches in the Southwest (*99*). Eighty-three ranches in Arizona and New Mexico, grazing an average of 2,087 head of cattle, controlled on the average 79,396 acres of land, distributed as follows:

	Acres
Owned crop land (0.08 percent)	62
Owned grazing land (8 percent)	6,185
Leased grazing land (29 percent)	22,852
National-forest range (9 percent)	7,002
Public domain (54 percent)	42,645

Another group of 11 ranches, each grazing about 1,500 cattle and 6,300 sheep, controlled an average total of 96,840 acres of land, comprising the following:

	Acres
Crop land (0.1 percent)	96
Owned grazing land (32 percent)	31,171
Leased grazing land (49 percent)	46,906
National-forest range (7 percent)	6,750
Public domain (12 percent)	11,818

The high percentage of private ownership of land in Texas is reflected in land tenure of individual ranches. Twenty-eight ranches studied in western Texas used an average area of 71,705 acres for 2,800 cattle, as follows:

	Acres
Owned crop land (0.04 percent)	30
Owned grazing land (73 percent)	52,574
Leased grazing land (27 percent)	19,101

Another group of three sheep and cattle ranches used an average area of 21,000 acres, all of which was owned land, and grazed an average of 303 cattle and 3,789 sheep.

One large ranching concern reflects the greater degree of crop farming in the Texas Panhandle country. This ranch, which runs 17,000 head of cattle, comprises 1,400 acres of farming land and 420,000 acres of grazing land, all of which is owned.

MOUNTAIN REGIONS

The mountain regions (Intermountain, Northern Rockies, and Pacific Northwest) are characterized by high mountain areas and low-lying valleys and plains.

The mountains supply large quantities of water, and irrigated crop farming is interspersed frequently throughout the grazing lands, usually along the base of the mountains and in the valleys. There are several large irrigation projects, and a wide variety of crops are produced which afford supplemental and fattening feeds for range livestock. Mountain meadows and subirrigated valleys produce native hay and cultivated crops.

As crop farming has developed in this region, the range livestock business has become more and more interlocked with it, and in fact the use of large areas of range land was possible only after crop-farming supplied required winter feeds.

Because of sharp changes in altitude and the high mountain ranges, there is a very distinctive seasonal use of the range between winter, spring and fall, and summer. The high mountain ranges are used for periods of 3 to 5 months in summer, the lower slopes of the mountains for periods of 2 to 6 weeks in spring and fall, and the low valleys and plains—either as range, farm pasture, or feed lots—are used during the winter.

The national-forest system covers much of the mountain area in this region and the greater part of the summer ranges and much of the spring and fall range is, therefore, used under grazing privileges permitted by the Forest Service.

There are large ranching concerns throughout this region, but the moderate-sized combined crop-farming and grazing ranches predominate. While there are innumerable variations, the following examples indicate size and type of ranches, the combinations of crop and grazing agriculture, and the means of land tenure of many ranching outfits in this general region.

Thirteen cattle ranches in Utah (*103*), with about 244 head each, used an average of 5,799 acres of land distributed as follows:

	Acres
Owned crop land (4 percent)	210
Owned grazing land (21 percent)	1,232
Leased grazing land (5 percent)	296
National-forest range (33 percent)	1,925
Public domain (37 percent)	2,134

An average of two typical sheep ranches in Idaho amounts to 4,820 acres of owned and leased land exclusive of use of national-forest and public-domain lands—1,030 acres of owned crop land farmed, and 2,415 acres of owned and 1,375 acres of leased range land grazed. During the summer national-forest range was used, public domain was grazed for about 3 months in early spring and late fall, and supplemental crop feeds were used during most of the winter. The average number of sheep grazed was 9,100 head, which is somewhat larger than the average for this broad region as a whole.

CALIFORNIA REGION

The bulk of the grazing lands in California and the crop farming which is closely integrated with use of the range lie within the great valley of the San Joaquin and Sacramento Rivers, which stretches through the interior of the State for a distance of over 500 miles.

The climate of this valley is unique in that the growing period occurs during the late fall and winter and spring. The range forage in the valley and along the lower slopes of the mountains is composed mostly of annuals which produce an abundance of excellent forage during the growing season but dry up and are of greatly reduced value in summer.

Since the mountain summer ranges furnish only a little over 10 percent of the range feed, livestock are largely dependent during the summer on crop land stubble and irrigated and subirrigated pastures.

Seasonal use revolves largely around croplands. Cattle for the most part use annual grass ranges during late fall, winter, and spring, and are summered on irrigated and other farm pasturage, subirrigated bottomlands, and on the national-forest mountain ranges. In the early fall they use largely grain stubble fields.

Sheep are grazed usually on annual grass pasture in late fall, winter, and spring, move to the national forests, or irrigated or subirrigated pasture and other croplands in summer, and use grain-stubble fields and irrigated pasture in the early fall.

California produces a tremendous variety of crops which provide large quantities of supplemental and fattening feeds. One hundred thousand tons of cottonseed cake, 350,000 tons of beet pulp, and large amounts of linseed meal and rice bran are produced annually. For the important Los Angeles market, large numbers of cattle and lambs are fed annually. Many lambs are fed by feeding companies with large plants and are sent to market as fast as conditioned during the season. California is one of the few States which produce early spring lambs.

The coast ranges, where there are some perennial grasses, are used to some extent yearlong, although winter feeding of supplemental crop land forage is also practiced.

Tenure of crop and range lands by livestock operations varies greatly with different concerns. Figures for two widely different counties show that 17 percent of the cattlemen and 28 percent of the sheepmen in Stanislaus County and 24 percent of the cattlemen and 52 percent of the sheepmen in Kings County own no real estate.

The 17 percent of cattlemen graze 29 percent of the cattle, and the 28 percent of sheepmen graze 51 percent of the sheep in Stanislaus County. In Kings County the cattlemen who own no real estate graze 56 percent of the cattle, and the sheepmen 82 percent of the sheep. There are a total of 69 cattlemen in Stanislaus County and 17 in Kings County. The total number of cattle grazed are 11,400 head and 2,526 head, respectively.

The dense population of California (5,677,000, or 38.8 percent of the total for the range country) makes meat production of great importance for local food requirements. This State at times draws for cattle on all the 11 western range States, and Texas, Canada, and Mexico. There is a lack of suitable range land but an abundance of cropland products for fattening. Therefore, the closely integrated use of crop and range lands is of extreme importance in maintaining maximum production of livestock.

These regional characteristics and their influence upon local agriculture serve to show how inseparable, throughout the West, the range and the farm have become. Starting with the independent use of native forage by the pioneer stock outfits, coming on down through the period of intense conflicts between the homesteader, the sheep outfits, and the cowmen, we now find each use so dependent on the other that the elimination of one would seriously handicap the whole economic and social order. Only through the closest kind of coordination can the full potentialities of the land be obtained. Furthermore, the corollary is obvious, that neither phase of this integrated agriculture can suffer serious impairment without seriously affecting the other, and the welfare of a whole region as well.

The wide range of conditions covered by the agricultural patterns only serves to emphasize the need for close correlation. The Mormon community with small intensively used acreages and small but essential herds or flocks, the hay from Snake River Valley fed to sheep and cattle which summer on the public domain or the national forests, the Easter lambs which are finished on the Salt River project, the large herds of the Southwest which give purpose to the irrigation of that region, the beet pulp and other agricultural byproducts which are used to finish livestock in Montana—these are just a few examples of the interlocking of western agriculture.

Dependent Population

Since the dawn of civilization the ranging of domestic livestock on native forage has been an important occupation of mankind. It has furnished a large part of the food and clothing and the basis for much of the trade and industry. But integrated crop farming and grazing is a more stable and permanent form of agriculture than grazing alone and this industry furnishes a source of occupation and of economic support to many people in the West today. The druggist, the lumber dealer, the beauty parlor operator, and the garage mechanic in a prosperous stock town are as fully dependent on livestock for a livelihood as is the cowboy or farm hand. Thus the 14,612,000 people in the range country in large measure depend on western agriculture for their welfare and prosperity. The degree of dependence varies greatly with the type of community life but four general groups stand out.

OUTLYING RANCHES

There are many isolated ranches in the range country located at distances from trading points or post offices, varying from only a few miles to 100 miles or more. The culture and standards of living are in general high, but great variations occur, from ranch headquarters equipped with radios, electrical appliances, and modern sanitation to the dirt-floor shack without any modern conveniences.

The dependency of these ranches upon the use of the range by livestock varies tremendously from the dry farmer eking out an existence on a submarginal farm to the large ranch having heavy capital investments in grazing, subsidiary crop lands, and range improvements dependent upon a sustained profitable production of livestock. Others depend partly upon grazing and crop farming or partly upon other endeavor. "Dude ranching", for example, has assumed considerable importance over the past 15 years.

COMMUNITIES

Range-land communities vary as widely in character as do the homes of the individual ranchers. The Spanish settlements along the Rio Grande since late in the seventeenth century have used the range continuously. Range lands around such settlements furnish most of the forage for milch cows, milch goats, and meat animals, which supply a major portion of the food, particularly protein foods, of the residents. The Mormon communities of the intermountain and southwest regions are social entities closely knit by ties of church. Many settlements, particularly on arable lands along streams or mountain valleys, and dry-farming areas have their social center and trading point in a combined post office and general store, a public school, an amusement hall, a church, and perhaps one or two additional small business establishments. These little communities, often adequate for the farming and ranching operations they serve, may well form the basis for a high type of American living.

Aside from communities which are largely dependent upon crop farming and livestock, there are many the support of which comes from a variety of other occupations interwoven into the economic complex, such as mining, lumbering, tourist trade, and hunting and fishing. These are of all varieties, from the thrifty modern settlement, with a definite social life and recognized social responsibilities, to the decadent submarginal farming town, with few or no social advantages and with no leadership to assume the responsibility of the community. Both types, and all between these extremes, are in varying degree dependent upon crop farming and livestock grazing for their permanent existence. Individually the hopes, aspirations, and happiness of many people and collectively their social and economic security depend upon the degree to which the range is available as a source of permanent support.

SUPPLY TOWNS

The characteristic type of supply town which serves the range country may be a distributing point for distances of 100 miles or

more on each side. Even though the populations are small, the total business transacted during the year may be very large comparatively. They embrace sizable wholesale and retail houses, and the ordinary business endeavors. Usually they support one or more churches and two or three fraternal organizations; good schools and reasonable opportunities for social diversions are available.

Although dependent upon a variety of trade, traffic, and industry, ordinarily the range livestock business and other forms of agriculture are among the important sources of their support.

Metropolitan Business Centers

Metropolitan business centers include cities such as Denver, Phoenix, Ogden, Salt Lake City, and others. They are wholesale receiving and distributing points for all commodities used in the range livestock industry, and for the products of that industry as well as other industries represented in the West. They provide stockyard facilities, livestock and agricultural commission houses, and in some cases meat-packing and processing plants, saddlery, harness, and other leather-purchasing and manufacturing concerns.

Bonds Between Western Agriculture and the Middle West and South

The extent to which the range livestock industry of the West contributes to the agricultural undertaking of the Midwest and South and industries of the East is not generally appreciated. With regard to the first, the relationship, which is mutually advantageous, rests principally in the furnishing by the West of feeder steers and lambs for fattening on Midwest farms. Western ranges are in general best adapted to the production of feeder stock. Although finishing on farms has increased throughout the West, the production of feeders is still greatly in excess of western requirements. Thus the fattening of range livestock in the Corn Belt offers the best possibility of marketing for this excess.

There are other advantageous features of middle-western fattening of range-produced steers and lambs. It offers Corn Belt farmers an opportunity for bettering their income by converting raw materials, such as hay, corn, and other grain, into finished products for human consumption. It also provides the farmer with the opportunity of turning his slack time into cash and for reducing the cost of finishing hogs that use feed lots with cattle. This is an important source of profit from the entire feeding enterprise.

In some instances, particularly during the fall of 1934 and winter of 1934–35, following the severe drought of the summer, Midwest winter wheat lands have furnished pasturage for large numbers of range cattle. Financially harassed farmers received a good income from this use, and ranchers were able to prevent severe drought losses and maintain breeding stock in good condition.

Conversely, supplemental winter feeding in the West offers markets for large quantities of Middle West shelled corn, oats, and other small grain. The total volume and values involved in such transactions are very difficult to determine, but they are unquestionably of great interregional importance.

The primary relationship between western ranching and the South is through use in the West of large amounts of cottonseed cake, meal, and other products for supplemental feeding of western livestock. To a limited degree the West furnishes foundation breeding stock upon which is being built a higher type of animal husbandry in the South.

Eastern manufacturers provide markets and processing plants for most of the western wools and mohair. Beef and mutton are also marketed mainly east of the range country.

Clearly, a permanently high level of security for the western livestock industry is of real importance to the Midwest, to the South and East, and to the Nation. That maximum benefits have not been obtained is a natural result of the industry's haphazard and planless development. Unsuited land-settlement policies, misuse of land, disregard for sustained production from range and ranch are among the factors that have given rise to maladjustments which must be corrected if a satisfactory contribution to the social and economic welfare of the West and the Nation is to be realized.

Effects of Maladjusted Land Uses and of Range Depletion

DRY FARMING OR RANGE HUSBANDRY

Before pioneer conditions of the Middle West would allow other forms of land use, sheep and cattle began to convert annual grass crops into regular market supplies of beef, mutton, wool, and hides. Then in a brief space of years the tall-grass prairies were transformed to waving wheat and corn fields and a solid pattern of farm homes was developed. The changes from ranching to crop agriculture in the Middle West were swift, decisive, and permanent. Because of these changes social and economic opportunities multiplied. In the tall-grass country this form of agriculture has amply justified itself, even though immense areas of fine grassland were plowed up in the transition process.

The contrast is sharp between this earlier and successful settlement effort and the later settlement that occupied the empire of semiarid range land still farther to the west. By the time the Middle West was well settled, the whole country was in the grip of a boom over free land to the west and again cattle were being pushed back by the plow. No systematic effort was made to classify the western lands or otherwise to guide settlers to the better soils or locations. "Let the devil take the hindmost" might have been the guiding principle of the mushroom type of settlement that developed in the range country. "Rain follows the plow" was an oft used argument to answer any who raised questions as to the adequacy of rainfall.

Major Powell's report of 1878 (*107*) contained a remarkably clear analysis of special problems to be met and essential changes in existing settlement policies needed to meet them. The report pointed out definitely the limited productivity of the semiarid range lands and emphasized the fact that crop agriculture would not yield a dependable family living in most of this area except under irrigation. But, as already explained, the vision and almost prophetic insight into the problem of developing a sound type of western agriculture

based primarily on range husbandry was ignored. Efforts to transplant a Middle West settlement pattern of 160-acre homesteads on the semiarid West continued.

As the wave of Western settlement rose higher and higher, the destruction of native grassland was everywhere accelerated. Settlers flocked deeper and deeper into the West where average annual precipitation dropped from 25 to 20 inches—on into the true range areas of 18, 15, and even less than 12 inches, where, during the growing season of frequent drought years, the precipitation often falls below 5 inches. These dry plains were clothed with grasses, "the most nutritious that livestock ever fed on" (*98*), but as farm land their limited productivity has in general proved pitifully inadequate to support a family permanently from the products of a quarter-section homestead.

Sometimes a series of two or more abnormally wet years occurred immediately after the sod was first broken up. The thin but rich layer of humus that had accumulated through the centuries, coupled with the high moisture retentive power of virgin soil, yielded bountiful crops under such favorable weather conditions. A period of rising prices for farm products set in at about the turn of the century that continued with some irregularity until 1919. These combined conditions served as a stimulus to more dry farming and greater range destruction by unwise plowing.

A considerable share of the homesteaders were, however, without experience in any form of agriculture, and would have been destined to failure as farmers under far more favorable conditions. On the other hand, the inherent difficulties of farming homesteads of this type were practically unsurmountable, even by those with ability and experience. "The Government bets title to 160 acres against the homesteader's filing fee that he will starve out before proving up, and the dry farmer usually loses"—is the way the land settlement policies have been aptly epitomized. As rainfall failed and prices fluctuated, more and more of these unwisely created dry-farm homesteads were abandoned. Fading hopes of those who had already invested years of labor and all their capital in a small dry farm were revived temporarily when the Government guaranteed $2.20 per bushel for war-time wheat. More sod was broken. But again drought, hot winds, hailstorms, grasshopper scourges, and other calamities occurred with discouraging frequency. The income from one good crop was quickly absorbed by living expenses and in buildings, fences, etc., necessary for occupancy of the new land. By the time the next good crop occurred a major portion was required to satisfy creditors, leaving little or no surplus for the inevitable lean years. Isolation, hardships, and want were the common portion of dry-farming families.

Fortune or good judgment enabled many to acquire units of adequate size and to set up a balanced form of agriculture keyed to western conditions, but in competition with established range outfits. Others continued straight dry farming. Slowly at first but at an increasing rate, desertion of dry farms took place even before the World War. Restricted grain exports, curtailed purchasing power, and deflated prices, coupled with an unusually severe drought in 1919, stepped up the rate of desertion to the proportions

of an exodus from many dry-farm counties. Tens of thousands of farmers gave up in despair. Covered wagons cargoed with the meager family household goods and trailed by a gaunt milk cow were on the road—somewhere. The number of farms in Montana declined more than 10,000 in a decade—a reduction of about 18 percent of the 1920 total. Four counties in the Big Bend dry-farming section of Washington lost 18 to 35 percent of their 1910 population by the time the 1930 census was taken. Parts of Colorado, the western portion of the Dakotas, Idaho, Oregon, and certain portions of other States had similar losses. Deserted homesteads, vacant schools, weed-grown cemeteries now bear mute testimony to the unwisdom of small homesteads on semiarid range lands. Such lands are adapted to permanent range use in units of considerable size with the support of some crop feeds, but not to independent dry farming.

SUBMARGINAL CROPPING INCREASES FEED AND CROP LOANS

Many unfortunate victims of the dry-farming boom still refuse to accept the inevitable or have been unable for one reason or another to join the thousands who deserted their homes. Thus the Federal Government and certain States have been forced, in a humanitarian effort to relieve acute distress, into the anomalous position of subsidizing these farmers to continue on farms that should be returned to range use.

More than 2,500,000 emergency crop and feed loans, aggregating slightly more than $287,000,000 have been made by the Federal Government in the 48 States since 1921 in an effort to relieve acute distress arising from numerous agricultural emergencies. The November 1935 Report of the Farm Credit Administration shows that 37.8 percent of the total was then outstanding and unpaid. This compares to 56.1 percent of outstanding and unpaid loans made in the 11 Western States. The higher percent of unpaid loans in the West is a reflection of the greater susceptibility of this region to such emergencies and to the maladjustments that have developed. Submarginal dry farming on land best suited for range use has been an important factor in the number and size of western loans and in delaying repayments.

SUBMARGINAL FARMING AGGRAVATES CROP-SURPLUS PROBLEMS

Not only did submarginal dry-farming attempts victimize the homesteaders and the range-livestock producers, but they have added greatly to the wheat-surplus problem. Immense quantities of wheat, produced from such lands during years of optimum weather conditions, competed with that grown on permanent crop land. The possibility of "making a killing" with an occasional bumper crop is a real lure to the operator even though the risk is high.

One $2,000,000 corporation ripped up 100,000 acres of Montana grassland between 1918 and 1923 (2). This gigantic sod-breaking effort took place on Indian lands leased from the Government at an exceptionally low rental. Hundreds of plow bottoms, scores of wheat drills, and batteries of threshing machines were operated by immense corporation tractors in a grandiose effort to convert semiarid

rangeland to profitable wheatfields. Operations for the first 4 years resulted in a net deficit. Eastern bankers retired with the loss of a substantial portion of their loans. Some profits accrued to the reorganized corporation for a brief period, but crops were so poor during the 1929 to 1934 period that more than $80,000 in rental fees was due at one time and the net deficit amounted to $600,000 during these 6 years. Only 20,000 of the 100,000 acres broken up are now being cropped. Through this abortive venture in wheat growing the Northwest has lost 80,000 acres of native grassland to Russian-thistle and cheatgrass. Production at a net loss tends to depress permanent cropland elsewhere into the submarginal class and is detrimental to the national economy.

In 1934–35, in an effort to remove the threat to overproduction, 40 million acres of submarginal cropland on 3 million farms was taken temporarily out of production (*175*) pending more permanent adjustments. Part of this is located in the West, where it is now estimated that a minimum of 15 million acres which has been cultivated should be permanently diverted from crop farming to pasturage or other forms of use. This area includes 7.2 million acres within "Problem 1" areas of the Resettlement Administration and at least 8 million acres additional in scattered tracts.

PLOWED RANGE LANDS REQUIRE REHABILITATION

Submarginal dry farming on land which nature intended for grass had reached its maximum and in many places had begun its decline by about 1920. Biological, social, and economic problems of great complexity are involved in restoring these abondoned dry-farm lands to permanent forms of use.

Nature has begun the process, but her methods of regrassing millions of acres of range land devastated by the plow and erosive processes are painfully slow. A survey to determine the natural rate of regrassing plowed lands of central Montana was conducted by Prof. E. W. Nelson of the University of Montana. He found that land abandoned for 11 to 15 years had a grazing capacity only 46 percent, and for 16 years and more only 57 percent as high as that on nearby native ranges themselves badly depleted by overgrazing. After careful investigations in eastern Colorado, Shantz (*125*) concluded that 20 to 50 years would be required for the short-grass type of grassland to reestablish itself after being plowed and abandoned. He further estimated that it might take a century for some types to reestablish the original cover where soil conditions were greatly disturbed by wind erosion.

About 78 million acres of native sod in the prairies and plains of the West were diverted to crop uses between 1900 and 1929. Not all of this has proved to be submarginal, as is the previously mentioned 15 million acres which should revert to public ownership. The attrition of the grassland by the plow still continues to some extent. It is probable that at least 20 million acres of plowed land in the West now require restoration to grass before they can contribute fully to the support of the region. Range rehabilitation by its very magnitude has thus become a national problem.

OTHER MALADJUSTMENTS

The attempts at submarginal dry farming, although an unfortunate and indeed, disastrous land-use practice, is not the only form of maladjustment that has contributed to the present acute agricultural situation in the West. An equally unfortunate practice, already described as a phase of land ownership, is the parcelling out of land in units of inadequate size. These were doomed to failure even on some of the better soils, if we are to judge by the almost universal trend, as shown in table 64 and figure 80, toward much larger units. Although the total area in all farm-ranch units has nearly doubled since 1910, the acreage in the 100–174 acre class has

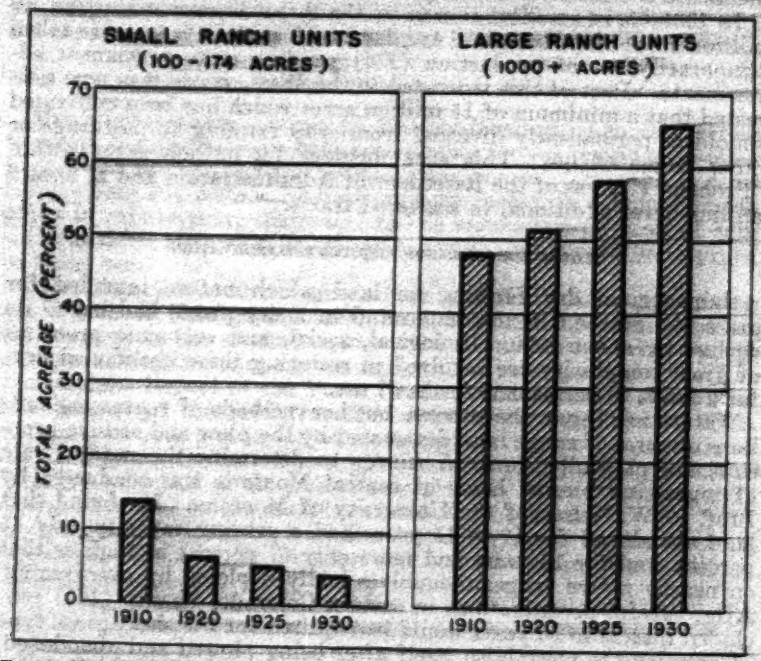

FIGURE 80.—The 20-year downward trend in the percent of total western farm-ranch acreage in small units is more than offset by the upward trend in units of 1,000 acres or more.

fallen off by more than 40 percent, and the number in this class has decreased by more than 37 percent; while in the same period units of 1,000 acres and more have more than doubled in number and nearly trebled in total area. This is strong additional evidence that small homestead units are not adapted to stability of agricultural development in the West and accounts in part for the heavy turnover in the smallest-size permit class of the national forests, as discussed in another part of this report.

TABLE 64.—*Trends in number and acreage of small and large farm-ranch units in 11 Western States*[1]

[TOTALS FOR ALL SIZE UNITS]

Year	Units		Area	
	Number	Percent	Acres	Percent
1920	[illegible]	100	[illegible]	100
1925	[illegible]	100	[illegible]	100
1930	[illegible]	100	[illegible]	100
1935	[illegible]	100	[illegible]	100
1940	[illegible]	100	[illegible]	100

UNITS OF 100-174 ACRES

1920	79,883	28.40	10,376,452	11.29
1925	102,661	27.51	13,222,047	14.00
1930	78,786	18.57	11,445,023	6.60
1935	70,715	14.17	10,195,305	5.45
1940	64,059	12.96	9,185,947	4.22

UNITS OF 1,000 ACRES AND OVER

1920	11,573	4.78	64,781,784	68.40
1925	14,000	3.68	62,574,963	46.73
1930	18,903	4.39	69,645,385	51.61
1935	27,084	5.43	105,980,632	58.29
1940	37,309	7.62	142,998,502	65.74

UNITS OF 4,000 ACRES AND OVER[2]

1920	3,053	0.84	48,576,057	27.94
1925	3,969	.74	55,321,503	25.15
1940	4,962	.99	80,445,990	37.02

[1] Data from the Bureau of the Census.
[2] Prior to 1920 there was no separate classification for units of 4,000 acres and over.

A recent study by the Forest Service discloses that 19,528 farm units comprising 2,224,037 acres located inside or adjacent to national forests had been abandoned prior to June 1934. These units averaged considerably less than 160 acres and many of them were located on rocky soil, steep slopes, or at high elevations where climatic conditions preclude successful crop agriculture. They were not only submarginal but many of them were so located as to interfere with lumbering, recreation, grazing, and other land uses on larger adjacent areas.

Although irrigation has been one of the substantial stabilizing factors in western agriculture its effects have not always been favorable. Thousands of acres of land once of the highest productivity have been waterlogged by irrigation developments. The alkali salts which have accumulated not only make the problem of reclamation by drainage extremely difficult, but also seriously impair possible future value of this land for range use.

The 640-acre stock-raising homesteads, previously described, have been another link in a long series of maladjustments that have continually interfered with the development of a balanced type of agriculture. Practically all of the land entered or patented under this law was already in use by established livestock outfits. The final results were to further intensify oversettlement, to increase de-

structive competition for range resources, and to raise operating expenses to former users without commensurate benefit to those who attempted to establish farm homes based on the products of a 640-acre homestead.

Maladjustment through improper use of land is well illustrated by the complex situation which has developed in an important grazing locality in El Dorado County, Calif., as revealed by a recent economic survey (*181*). The settlement pattern and land utilization practices that grew up during the gold-rush days and succeeding boom periods no longer meet the changed economic and social needs. One evidence of the change is the decline in the population itself, which has been accompanied by serious difficulties in maintaining local school and road facilities and reasonable standards of rural living. The present maladjustment has resulted partly from or is reflected by such factors as (1) a decrease in grazing values through encroachment of brush and other inferior plants; (2) a one-third reduction in tilled agricultural lands between 1863 and 1930; and (3) a dwindling acreage of virgin timber along with an increase in neglected cut-over land. Overgrazing, fire, and destructive logging have been active forces in this change.

EFFECTS OF RANGE DEPLETION ON INTEGRATED WESTERN AGRICULTURE

CROPS AFFECTED BY RANGE DEPLETION

One excellent example of the bad effects of depleted ranges on crop production is the enormous periodic losses caused by beet leafhoppers to the sugar beet, tomato, and bean industries of the West. Surveys by the Bureau of Plant Industry and the Bureau of Entomology and Plant Quarantine have determined that Russian-thistle, mustard, and a few other weeds are the favored plants on which the beet leafhoppers survive between beet harvest and the next crop. Large areas of overgrazed range and abandoned farm lands on which these host plants predominate were found adjacent to important irrigated beet-, tomato-, and bean-growing areas in Washington, Oregon, Idaho, Utah, Colorado, and California. It was estimated that the beet leafhoppers reduced the beet crop in 1934 in six south Idaho counties to less than 10 percent of the 1933 crop. Sugar factories in at least two of the nearby cities failed to open in the fall of 1934, with a loss of employment of about 500 men and a loss to the growers exceeding $1,500,000.

OVERCOMPETITION INFLATES LAND VALUES AND PRODUCTION COSTS

Unfortunately, the number of livestock owned rather than the sustained grazing capacity of available ranges has been the main criterion of the wealth of livestock outfits. The lack of a simple and dependable measuring stick whereby stockmen or bankers might determine the grazing capacity has resulted in a tendency to overestimate, and in a general failure to recognize the limits of per-acre productivity. After the range was already stocked to the point where there remained no surplus of forage, new ranches wedged in. Efforts to increase size of herds continued with little regard for supply or cost of feed. As a result, droughts, grasshoppers, and

other emergencies brought acute and frequent feed shortages. In an effort to make up the growing deficiency of range feed for what was really excess numbers of livestock, additional land was brought under cultivation and irrigation expanded, often at unprofitable cost per acre. The resultant overcompetition for both range and crop land led to inflated prices which in turn encouraged heavier stocking and again more land purchase in a vicious circle that often resulted in acute economic distress for the operator and extreme abuse of the range.

That stockmen realize the burden of private ownership and have tried by leasing to escape from it, was shown in the previous discussion of land tenure. The extent of the extra costs is indicated by a survey made by the Forest Service in the 11 western range States from 1922 to 1924. Data were collected on 183 tracts of land comprising more than 625,000 acres owned by livestock producers near the various national forests. Based on taxes and interest on the land investment, the cost of pasturage to the owners of these lands averages $1.02 per animal-month for cattle, and 17 cents for sheep.

On 1,675 tracts of grazing land aggregating more than 16 million acres leased from others by stockmen in this same region, the cost per animal-month averaged only 18 cents per month for cattle and 3.5 cents for sheep. The cost of pasturage was thus almost threefold for sheep and more than fivefold for cattle to the man who owned his range pasture as compared to the man who leased from others. In other words, range forage on the average cost the man who owned the land $12.24 for 12 months' pasturage for cattle as against $2.16 for the man who leased from others. The cost of ownership which the stockmen escapes is, however, borne by the lessor, and thus the loss in community income is in nowise reduced through the cheaper operating cost on leased land. Many foreclosures and bankruptcies might have been avoided during deflation periods in 1921 and again in 1934 had the danger of inflated land prices been more carefully considered.

The owner of land has the advantage of assured use, but such a high differential is an exorbitant price to pay for secure tenure, desirable though it is. He is under a tremendous handicap in competition with the producer who operates on cheaper feed. However, short-term competitive leases are very troublesome because a competitor may bid up the price to an unreasonable figure and actually take over the lease at a critical time. Thus the operator walks a tightrope, striving for stability on one hand and low costs on the other.

EXPENSIVE SUPPLEMENTAL FEED REPLACES CHEAP RANGE FORAGE

As the grazing capacity of native ranges declined from both overgrazing and plowing, efforts to maintain or increase numbers of livestock on both farms and ranches have continued without counting the cost of the increased proportion of harvested food required. The livestock industry of the West must in large measure rely on cheap range forage to offset the distinct disadvantage of high cost of transportation to market. Yet, there has been a gradual change from almost complete reliance on the range forage to the use

of immense quantities of hay and other harvested crops, including cottonseed cake and other special products shipped in.

Irrigation and dry-farm forage production on many millions of acres have been essential to provide security against severe winters or drought years. In no other way was it possible to build up an integrated type of agriculture with range husbandry occupying its proper place in the scheme. However, it now seems probable that the increasing use of supplemental feed has progressed beyond the point that yields best profits, as is fully brought out in the discussion of excessive stocking earlier in this report. Harvested crops, concentrates, and irrigated pasture provided 43 percent of the total feed requirements of livestock for 11 western range States in 1935. Saunderson [*] reports a long-time trend toward shortening the period on range forage and lengthening of the wintering period in Montana and that better control and use of range land would allow the shortening of the feeding period by a month or approximately one-third. Similar increases in the use of winter feed have taken place in most sections of the range country, as narrated of conditions in Colorado (*26*).

> In the early days * * * cattle came through the winters in better shape on bunchgrass with little or no hay than they do at the present time when 1½ to 2 tons of hay are fed per cow. * * * Cattlemen in early days were able to round up and ship their beef in July, whereas now no beef can be gathered and shipped till late fall with the exceptions of small bunches that can be kept in special pastures.

The extent to which this situation applies varies by States and by operators. The southern portion of the range country has a shorter feeding period, but here, also, there is the tendency to substitute great quantities of cottonseed cake and other expensive feeds for cheap range forage. Numerous studies of the cost of production agree in general with the conclusion reached in Wyoming (*170*) to the effect that livestock profits are due to gains made from grazing the ranges and that those operations having the lightest supplemental feed requirements have the greatest opportunities for profits. Thus, failure to adjust operations to reduced grazing capacity of range lands reacts on profits with smashing effect when livestock prices are low.

Safety requires that a substantial supply of supplemental feed be kept on hand even though the cost may be greater than range forage. There are very definite limitations, however, to the use of such expensive feeds for normal range operations. Entirely different considerations apply where it is possible to obtain a price advantage through the use of western-grown feeds in fattening operations, as will be discussed later.

Infectious abortion spreads less readily among cattle on the range than in herds that are crowded together on feeding grounds (*67*). This is one good reason for keeping range cattle on feed lots no longer than is absolutely necessary. Experienced stockmen commonly believe that livestock will winter in stronger and more healthy condition as a result of using range forage to the maximum than by the use of a high proportion of supplemental feed.

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[*] See footnote 24, p. 208.

DEPLETION OF KEY AREAS

Pioneer stockmen of the West had the opportunity to use advantageously located key areas essential to best use of adjacent range land. These tracts provided feed, water, and shelter for calving or lambing at low cost or for fattening animals for market without other feed. They served as holding grounds, horse pastures, connecting links between summer and winter ranges, driveways, and otherwise as indispensable aids to economical operations. Dry farming claimed many of these, but questionable range practices are responsible for the depleted condition of many more such key areas. Abuse of the lieu selection laws and subsidized homesteading by employees have allowed virtual monopoly of all available water for miles, which resulted in the range abuses and range wars of varying degrees as narrated in the history of the range. Very careful management on many of these abused areas and in some cases artificial reseeding will be necessary to restore a forage cover.

UNBALANCED SEASONAL USE OF RANGE FORAGE

Spring and fall ranges perform a particular function in the economical production of range livestock. The end of the winter season is a critical time; livestock become dissatisfied with hay or other dry feed as soon as early spring growth appears. The heaviest death losses of the year may occur after grasses first appear but before they are sufficiently abundant to fully maintain livestock.

Early settlement took place to a very great extent on areas especially adapted to spring-fall range use. As depletion extended progressively farther from the ranch headquarters, the more expensive harvested feeds had to be used earlier in the fall and later in the spring. Gradually the overgrazing extended to the summer ranges at a greater distance. In many places improper use and depletion of spring and fall ranges has progressed to the point that livestock must be held on alfalfa and hay meadows and other high-value crop land so late that these crops have been damaged severely. Depletion of the spring-fall ranges before summer ranges are ready for use has been the cause for one of the most difficult problems in grazing administration on national forests, because of the insistent pressure for grazing these public ranges prematurely.

Improper use of range forage has destroyed much of the value of many spendid ranches that were once highly productive enterprises. The Grasshopper Ranch of about 15,000 acres located in Lassen County, Calif., is one of many such examples. This ranch was purchased about 1900 and with nearby public-domain range it supported about 4,000 cattle and horses for a considerable period of years. During favorable years it produced upward of 3,500 tons of hay and was then one of the most valuable stock ranches in northern California. At one time the owner refused an offer of $200,000 for it.

Overgrazing coupled with improper seasonal use of the surrounding public domain gradually unbalanced this ranch as a productive unit. It was sold under foreclosure in 1923 and has changed hands several times since at greatly reduced prices. Hay production is now only a small fraction of the former quantity. Even by

grazing the former hay lands it is only possible to obtain feed for about one-third of the animals during the summer that were formerly maintained yearlong on the ranch and the range land tributary to it. Other ranch properties throughout the West have suffered a somewhat similar fate.

Immediate reduction in numbers of livestock sufficiently to restore depleted spring-fall ranges is a grim alternative. This may be avoided by increased use of supplemental feeds, but this course endangers the chances for profitable operations. A third course, ultimately suicidal to the industry, is to relieve the overgrazed spring-fall ranges by still heavier use of ranges needed at other seasons, most of which are already overgrazed. All three courses may serve as temporary adjustments but in the end the situation demands drastic reduction in stocking to restore a balance between livestock numbers and range and crop feeds.

DEPLETION AFFECTS MARKETABILITY OF LIVESTOCK

As previously stated the western livestock industry is absolutely dependent upon its one natural advantage over other regions, the availability of cheap range forage to overcome the handicap of extremely high freight rates. Parr et al. (*99*) give one example of a shipment of two cars of cattle from Arizona to Kansas City that netted only $4.70 to the owner after freight was paid. Labor, range improvement, and other charges are high and great extremes of weather cause relatively high losses under the best management possible. Range depletion coupled with speculative prices for range lands, high taxes, and other fixed charges have reached a point where the natural advantage of cheap range forage is being destroyed. The following comparison (*134*) is an apt illustration of this situation:

> During the seasons of 1887, '88, and '89, 3-year-old steers were sold on the Denver market for Christmas beef weighing 1,200 and 1,500 pounds, without feed other than grass and native hay. * * * Ten years later steers from the same quality of stock, handled in the same way, on the prairie pastures were sold as feeders, but they weighed only around 1,000 pounds. Under the controlled open range system our heritage was soon wasted and almost destroyed.

Range forage in ample quantities has demonstrated its ability to produce a considerable proportion of grass-fat lambs and steers, classed as "killers" at the markets. This is the class that ordinarily receives the best competition between packers and yields greatest profits to the range producer. Based on a recent 6-year average of Chicago prices during September to November, inclusive, the price per cwt. for Common steers was $5.17, for Medium $6.86, for Good $8.57, and for Choice $9.84, in the 900- to 1,100-pound group. Most western range steers, with ample feed, have the breeding and quality to qualify for the Medium and many for the Good grade, but when shipped from overgrazed ranges they fail to reach the weight or grade to which they are otherwise qualified. An increase in weight from 900 to 1,000 pounds or more and in grade from Medium to Good would increase the average price from $61.74 to $85.70. The $23.96 difference represents the premium on ample range forage per animal at a cost of but a fraction of this amount.

Slightly thinner livestock, called "two-way animals", are suitable for immediate slaughter but are also in demand by feeders who

wish partly fat animals that may be finished for higher prices during a short feeding period. The premium to be had by "finishing" this type should more often go to the hay and grain farmer of the West. Even this class generally commands better competition and higher prices than those that are unsuited for slaughter except as "canners" and "cutters" at a heavy price discount. Discarded dairy animals furnish a constant supply of the latter class of cattle. Although it requires more forage to produce the maximum percentage of "finished" and "two-way animals" than it does for poorer conditioned stock, the former may yield far better profits than the larger number of their animals produced from a skimpy allowance of feed.

BENEFITS OF IMPROVED BREEDING NULLIFIED

Range users of the West have for a long period of years followed a consistent practice of herd improvement. No other part of the country uses a higher proportion of purebred sires or has culled out low-grade cows and ewes more consistently to improve and standardize herds. The benefits of this herd improvement work have been nullified to a very great degree by the fact that numbers have been too great to develop the potential possibilities with the limited feed resources used. The New Mexico Agricultural College in a recent unpublished report states that cows on a rehabilitated range area develop to weigh about 900 pounds and calves at 9 months to about 380 pounds. On adjacent overgrazed ranges average cow weight is about 700 pounds and calves about 330 pounds average.

During a 3-year experimental period, high-grade Hereford calves from overgrazed ranges in Montana averaged at weaning time 48 pounds or nearly 15 percent lighter than those of similar age and breeding that had a more liberal allowance of range forage. The cows from overgrazed ranges in this same experiment—depending on the time of year—averaged 40 to 90 pounds lighter than those with a more ample supply of range (*76*).

The relationship between ample feed and good breeding is summed up by Hart and associates (*69*) in California in the following manner: "Without proper feed supply, our most highly bred animals must revert to scrubs or fail in the struggle for existence." This supports similar conclusions reached in South Africa and in England.

LOWERED CALF AND LAMB CROPS AND INCREASED LOSSES

Range depletion has proceeded so rapidly that heavy livestock losses and low calf and lamb crops continue as major handicaps to profitable production. Thus the tremendous expenditures which have been made to provide greater security of operations have been but partially effective.

In a 5-year study of 84 sheep ranches in Montana, Saunderson (*121*) found a variation from 1 to 15 percent in the death loss, from 50 to 105 percent in the number of lambs matured, and from 55 to 86 pounds in the weight of lambs at marketing time. The condition of the ranges used and the type of management were major factors in these variable results. Walker and Lantow (*174*)

report a loss of 15 percent of the cattle in a study of 112 New Mexico ranches, 78 percent of this loss being due to starvation directly correlated with poor range conditions during a dry season.

Annual death losses on the Jornada Experimental Range for the period 1915 to 1923 are reported by the Forest Service to be 1.7 percent as compared with 9.63 percent on nearby New Mexico ranges. Corresponding calf-crop percents were 70.5 and 45, respectively (figs. 81 and 82). The direct relation between calf crop and range feed is shown also by the Montana range experiment already mentioned. In

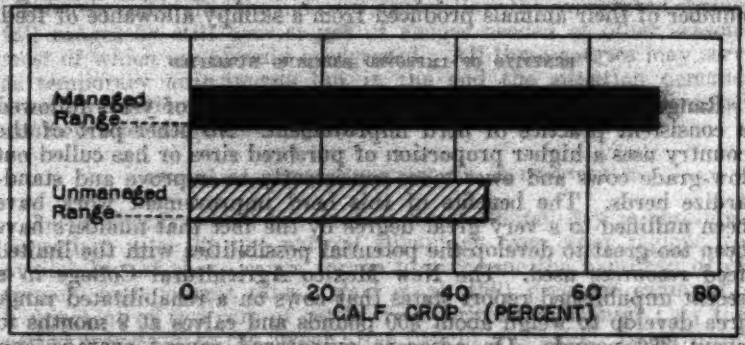

FIGURE 81.—On comparable New Mexico ranges, calf crops during drought were about one-third smaller on depleted range than on nearby managed range.

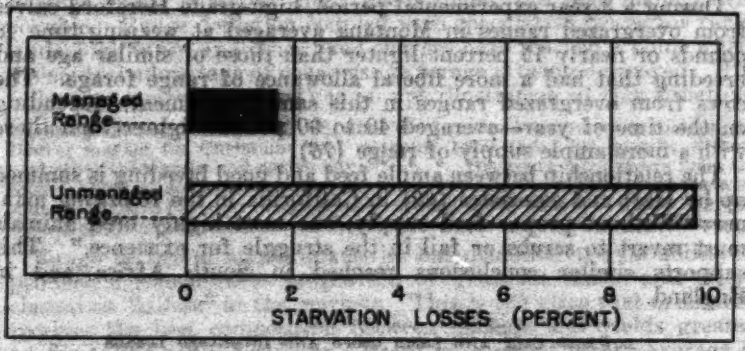

FIGURE 82.—On the same ranges as in figure 81, starvation losses during drought were nearly six times as large on depleted range.

this experiment cows on overgrazed range produced a 70-percent calf crop during a 3-year period, while those of similar age and breeding in adjacent range pastures that were conservatively grazed produced an 81.7 percent calf crop at a lower net cost of feed per pound of calf weight. This tends to bear out the conclusion reached for Wyoming ranges (*170*), that calf crops can be brought up to 80 percent before the point of diminishing returns is reached. There can be little doubt that reduced breeding efficiency and excessive losses are caused by depleted ranges and poor management.

LOST SOIL FERTILITY AND INCREASING MINERAL DEFICIENCIES

Permanent agricultural use of most soils requires a systematic return of fertilizing elements that are removed yearly, but this practice has not been followed or considered practicable for range lands. Trainloads of livestock move annually to the feed lots of the Middle West and help maintain fertility there to the net loss of western ranges. There is growing evidence of phosphorus or other mineral deficiencies on numerous widely separated western ranges that tend to curtail profits, through impaired health and breeding efficiency of range animals (*97*, *123*, *182*). Range depletion from this source may not yet be widespread or serious, but the constant drain must hereafter be considered in western agricultural practices. Leaving a substantial portion of the annual forage growth to rebuild humus and preserve mineral constituents on the range land, is one way to reduce the present excessive drain on soil fertility.

The need for maintaining the soil fertility of cropped land by the use of manures from feeding hay, certain grain, and other feeds may warrant a far greater development of western fattening operations. This may give a profitable outlet for feed reserves which, for safety of the breeding herd, must be on hand through critical periods, but which may be used for fattening of some animals after the emergency period has passed. There is much to be gained by such a development in maintaining soil fertility on western range and crop lands and as a means to a more orderly marketing practice.

CHRONIC RANGE EMERGENCIES AND FORCED SALES

Year after year range feed supplies are so low by late summer or early fall that the producer must ship his livestock with little reference to market conditions or the condition of the animals. Holding of market animals so greatly endangers the successful maintenance of the breeding herd that even under usual conditions the transaction too often amounts to a forced sale. Drought, grasshopper infestation, financial deflation, etc., have occurred with such disturbing frequency that range husbandry has gained the reputation of being in a state of "chronic emergency." Scarcely a year has passed since the great "die-off" of 1886–87 that some part of the range country has not experienced some such emergency. The most far-reaching of these catastrophes occurred as a result of the 1934 drought. Resources of the Federal Treasury were called upon to finance the purchase of drought-stricken livestock from 904 counties in 16 of the 17 western States covered in this report, as well as in several eastern States. Table 65, from a preliminary report by the Emergency Drought Relief Administration of May 31, 1935, does not include a minor part of the late purchases. It includes, however, all purchases made in the six Plains States which are but partially within the scope of this report.

TABLE 65.—*The 1934 drought-relief purchase program,[1] cattle and sheep [2]*

State	Farms and ranches selling—		Livestock out of total inventory certified for payment				Total over 1 year old and over [3]	Total payments		Average price per head for cattle
	Cattle	Sheep and goats	Cattle		Sheep [3]			Cattle	Sheep [3]	
	Number	*Number*	*Number*	*Percent*	*Number*	*Percent*	*Percent*	*Dollars*	*Dollars*	*Dollars*
Western States:										
Arizona	2,720	310	161,200	18.1	11,567	4.6	13.0	3,416,761	92,694	14.39
California	2,267	167	13,724	18.4	2,307	2.1	8.3	288,775	46,174	14.15
Colorado	10,240	1,[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	14.18
Idaho	5,227	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	14.18
Montana	15,227	2,[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	13.85
Nevada	1,210	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	14.08
New Mexico	10,224	4,[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	14.05
Oregon	6,[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	14.05
Utah	10,[illegible]	2,[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	14.77
Wyoming	7,[illegible]	[illegible]	205,716	62.7	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	14.08
Total	85,139	10,728	1,635,200	35.9	2,282,650	12.5	37.7	26,471,705	4,465,600	14.97
Plains States:										
Kansas	14,946	122	621,943	21.3	6,[illegible]	12.6	24.6	[illegible]	15,[illegible]	14.44
Nebraska	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	13.73
North Dakota	[illegible]	2,[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	14.08
Oklahoma	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	11.93
South Dakota	[illegible]	2,[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	14.24
Texas	148,[illegible]	10,[illegible]	3,[illegible]	[illegible]	1,[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	12.18
Total	201,[illegible]	12,[illegible]	5,[illegible]	32.2	1,[illegible]	14.6	27.6	72,[illegible]	2,[illegible]	13.17
All States	470,[illegible]	22,[illegible]	7,[illegible]	33.7	3,[illegible]	13.1	33.6	[illegible]	7,[illegible]	13.69

[1] Data not final.
[2] Purchases were made in 904 counties in the above States; purchases were also made in other States.
[3] In 16 Western and Plains States 350,014 goats (Angora does) were certified for payment at a total cost of $490,019.60.

Generally speaking, the $9 flat rate per head paid for sheep was not materially below normal prices, considering the advanced age and poor condition of those purchased. This price for old ewes did not represent a serious loss to the sheep producers, although they lost heavily in other ways as a result of the drought.

The low prices paid for cattle were gladly accepted by the producers with full knowledge that they represented but a fraction of normal values, because it was realized that prices would have dropped to much lower levels and probably to zero for certain classes in the absence of Government purchases. Producers thus suffered only a part of the losses that otherwise would have occurred.

If the average price of $13.40 per head for these drought-stricken cattle is assumed to be two-thirds of the true normal value, then the loss to the producers amounted to $6.70 per head or more than $48,000,000. Even this staggering total makes little allowance for the thousands of purebred cows, heifers, and bulls that were sacrificed at $20 or less per head along with the scrubs. It makes no allowance for loss of ranch income that must remain below normal for many years, nothing for reduced tax receipts, and nothing for the losses suffered by the Government and hence by the tax-paying public in completing the purchase program.

A substantial part of these losses might have been avoided had the ranges been stocked on a proper, conservative basis and had there been the type of integration between the ranges and farms that would have assured maximum amounts of supplemental feeds for just such emergencies. An occasional ranch located in the heart of drought-stricken areas, which had followed a conservative grazing policy and that had accumulated supplemental feed reserves, weathered the drought without major sacrifices and marketed nearly normal numbers of livestock during 1935 at prices far above those paid in 1934.

Enormous as this tragedy was, there was about it a certain inevitability. Depleted and punished ranges spell economic distress. Overgrazing the range eventually exacts a heavy penalty. Because the 1934 drought came during a general depression the effects were especially severe.

One compensating item may be recorded as the result of the disastrous drought. In certain small sections 80 percent or more of the livestock were removed from the long-suffering overgrazed ranges. Nature may have the opportunity to rebuild the range where reductions were so heavy. In other cases, where the drought reductions were not sufficient to offset the excess stocking, depletion still continues.

Reports are already current that a more favorable growing season in 1935 canceled all traces of the drought and of the half century of overstocking that preceded it. Such reports are dangerous. Severely depleted ranges cannot be restored in one season, highly favorable though it may be. Sample-plot data are presented in the preceding chapter of this report showing that forage cover is far better on protected areas than across the fence where heavy grazing has been the rule. According to records at the Hays, Kans., Experimental Station (*122*) drought reduced the density of grama and buffalo grasses 44.4 to 74.8 percent, depending on the extent grazed.

The theory of immediate recovery from the effects of drought is disproved by the fact that, after a favorable spring season in 1935, total density of all vegetation on two range areas at Miles City was 67 and 73 percent less than in 1933, based on detailed plot maps.

It will be unfortunate indeed if stockmen and credit agencies fail to grasp this opportunity to build a sound foundation for a stable agriculture by more conservative range stocking, supported by commensurate supplies of home-grown supplemental feed.

DECLINE OF POPULATION AND COMMUNITIES

Definite figures are not available to show the relative decline of business activity in towns and communities within the areas where range depletion and unbalanced agriculture exist. It is clear that a serious decline in purchasing power is the cause for a high proportion of vacant stores, garages, banks, and other business establishments in many western communities. The remaining business men in such communities will bear witness to the reduced trade opportunities.

A decline of population is one reliable index from which the economic welfare of the community may be judged. The population of most western counties continues to increase but in many others heavy population losses have been recorded as a result of misdirected agricultural endeavors. Fifteen counties chosen from such areas in 6 States (table 66) lost nearly 25,000 people, or about 21 percent of the total, during 10 years prior to 1930. These losses range from 4.4 to over 40 percent and illustrate somewhat the extent of the maladjustments in western agriculture. The population of Bluff, Utah, has declined approximately 90 percent since 1900 as a result of range depletion and erosion. Numerous other small once-thriving villages have had a similar fate.

TABLE 66.—*Population decrease in selected counties of dry-land range regions*[1]

State and county	Population		Decrease
	1920	1930	
	Number	*Number*	*Percent*
Washington:			
Douglas	9,302	7,551	18.8
Grant	7,771	5,666	27.1
Lincoln	14,141	11,176	21.0
Oregon:			
Morrow	5,617	4,941	12.0
Sherman	3,520	2,978	22.2
Jefferson	3,211	2,291	28.7
Montana:			
Custer	12,194	11,242	7.8
Musselshell	12,089	7,762	35.8
Garfield	5,205	4,233	20.4
Wheatland	5,619	3,731	33.2
New Mexico: Socorro	14,083	9,611	31.8
Colorado: Mesa	5,129	4,861	5.2
Idaho:			
Owyhee	4,804	4,198	12.6
Clark	1,809	1,125	40.5
Fremont	10,360	9,934	4.4
Total	116,319	91,473	21.4

[1] U. S. Bureau of the Census, Population 1930, v. 1 (*137*).

The full effects of the situation cannot be measured in economic terms alone. A tremendous toll of human wastage is involved in years spent in futile effort to establish a home and a competence. Especially for the women and children, often undernourished, the isolation and the scarcity of schools, medical facilities, and social opportunities have been a heavy cross to bear—too often it has been heavier than could be born. Bright hopes that sustained the pioneers change to dispair as the necessity arises to abandon all and seek a new home and a new way of living in an uncertain future.

The number of such families is not known. Were it not for relief and soup kitchens, the tragedies and suffering would be even more distressing. Even though the extent of this human wastage cannot be definitely measured, it is clear that it has been accentuated by planless, unbalanced forms of agriculture in the West.

Range Land Submarginal for Private Ownership

The various maladjustments in the use of land already discussed raise sharply the question of whether the poorer range land is not submarginal for private ownership. A considerable acreage of such land is so low in productivity that whether it can remain in private ownership is questionable. The prevalence of tax delinquency, the amount of land abandonment, the low standard of living, the extent of local rural relief, and the rehabilitation program in many localities serve to force a recognition of the problem.

Two classes of land are involved. These are (1) range land with a very low grazing capacity due either to natural deficiencies of soil and climate or to misuse that has caused a degree of depletion necessitating extremely light stocking for a long period of years to effect rehabilitation; and (2) much of the land on which the native cover has been destroyed by cultivation, which has proved to be unprofitable if not unsuitable for that use, and which must be revegetated artificially in order to restore its forage cover.

Insufficient information is now available to determine just what areas should be classed as submarginal for private ownership. Taking into account, however, the various factors which have a bearing upon the matter, there is little question but that there are several score millions of acres in the first classification. It has been estimated that nearly 25 million acres of land once cultivated is now abandoned to cultivation. Most of this area is of such low productivity that it does not justify private ownership, and on a considerable part the owners have actually moved away.

Although no satisfactory formula has been worked out whereby the exact point at which land becomes submarginal for private ownership can be identified, many of the major contributing factors are well known.

Naturally Low Productive Capacity of the Range

Range lands which, owing to low average rainfall, poor soil, or other unfavorable natural conditions, have extremely low grazing capacity, are poorly suited to private ownership. Among other things, the relatively higher cost per animal unit of investment in water development and other range improvements and of handling

livestock contribute to the inability of private owners to retain low capacity as compared to more productive range. For example, it has been shown that much of the southern desert-shrub type has a year-long grazing capacity of only about four or five cows per section of land. This range is poorly watered and requires large investments in water development and fencing to make it fully usable. Often deep wells each costing $5,000, or more, and half a mile of fence per section, costing about $150, may be required. Assuming that one well to a township would be sufficient, it is obvious that a resulting capital investment of $30 to $75 per animal grazed might be required for these two improvement items alone. To develop range at such high cost per head at once places the owner at a disadvantage as compared to the operator on higher capacity land where the same amount of improvements serves a much larger number of livestock. Low productivity coupled with the high frequency of drought in a large degree account for the high percentage of public domain remaining in parts of the Southwest and the intermountain region.

DROUGHT OR OTHER CLIMATIC HAZARDS

Private ownership is not attractive in areas threatened with near failure of forage crops by frequent drought or occurrence of blizzards, since these inflict heavy losses or high cost of supplemental feeding. Range livestock production is much more hazardous in most of the semiarid Southwest, for example, with a drought expectancy of 2 to 4 years in 10 than in the sand hills of Nebraska with a drought expectancy of 1 to 2 years or less in 10.

ACCESSIBILITY TO MARKET

The freight-rate differential from ranch to markets likewise has a great influence on unit production costs and the ability of range areas to support private ownership. At the one extreme are the Illinois farm pastures close to the central market; and at the other is the hinterland extending from Montana to Arizona, where local demand is small and distances to central markets are great. The partial effect of this factor on gross income per unit of salable product is shown in table 67. The Chicago market was chosen for this illustration because prices there quite closely control those on the other midwestern livestock markets. The item of shrinkage in transit is an additional factor which varies with the distance or time enroute, but reliable data are not available.

It seems obvious that, other things being equal, land values for cattle production should be less in Idaho with a $12.20 per head cost for transportation than in Nebraska with $6.71 or Illinois with $3.85 per head. Likewise the value of land for sheep raising will be influenced by the differential of $0.69 per lamb in South Dakota as compared to $0.99 in Montana. Certainly, other things being equal, the cost of getting the product to market does influence the value of range land and may reduce it to a point below that attractive to private capital.

TABLE 67.—*Distribution costs to producer from range States[1] to Chicago market*

CATTLE

State from which shipped	Freight per hundredweight	Other costs	Total per hundredweight	Cost per 1,000-pound steer or 70-pound lamb
Idaho	$0.86	$0.17	$1.13	$12.42
Montana	.71	.26	.97	10.67
Oklahoma	.73	.19	.91	10.01
Nebraska	.45	.16	.61	6.71
South Dakota	.66	.17	.83	9.09
Illinois	.30	.16	.46	5.05

SHEEP

Idaho	$0.17	$0.55	$0.72	$1.20
Montana	.07	.26	.33	1.14
Wyoming	.20	.44	1.64	.70
Oklahoma	.73	.66	1.39	2.39
Nebraska	.45	.16	.61	1.05
South Dakota	.66	.24	.90	1.55
Illinois	.30	.16	.46	.81

[1] Bureau of Railway Economics (37). Based on period of 365 mine days. Three weeks' periods in fall, 1924-30, inclusive.

TAXES AND TAX DELINQUENCY

Theoretically, the tax on land is based on its productive capacity and should be equalized accordingly. Actually, it is too often the case that range lands are grouped in one or two valuation classes for the purpose of taxation, and the poorer land must support a tax per animal unit of grazing capacity many times greater than the better lands within the same valuation class. For example, in some counties a uniform tax of 5 cents per acre is assessed on all range lands, whereas, based on grazing capacity a tax ranging from 2 to 10 cents per acre would be more equitable. The operator whose range will support only 1 animal year-long for each 100 acres at 5 cents per acre pays a tax of $5 for each animal unit, whereas the operator on range which will carry one animal for each 20 acres pays only $1. Adjustments in the tax base would remedy this situation, but changes have been made so slowly as actually to make taxation a factor operating to defeat private ownership.

This inequitable system, coupled with other range-land disadvantages due to naturally low productivity, depletion, and allied factors, combine to multiply tax delinquency. As already brought out, in Montana, Colorado, and Oregon, where studies of the tax problem on farm and range lands have been made, a serious situation prevails. These are but examples; practically all western States are affected in an important degree.

Several million acres of range land has already reverted to States and counties for tax delinquency. That this reversion, as well as the remaining area making up the total of 65 million acres in State and county ownership, together with nearly 150 million acres of usable range in the public domain and minor reservations to which the stock-raising homestead law applied, are still in public ownership, clearly indicates that there is a large acreage submarginal for private ownership. Another indication of submarginality is

the failure of homesteaders to prove up on nearly 20 million acres of unperfected entries still on the records.

COST OF RESTORATION AND REHABILITATION

The extent to which the native forage cover has been depleted is a major factor in the suitability of range land for continued private ownership. Where the grazing capacity has been so far reduced that a large acreage per animal unit is required, the possible returns from the productive capacity are likely to be so low that the land cannot support taxes, interest, and other costs and afford a return to the owner. The added heavy expenses required for rehabilitation increases the capital investment beyond the possibility for private ownership.

Much of the now depleted privately owned range land probably never was suited to private ownership. It has been successfully held during the depletion period because returns were then based on a yield in excess of the sustained productivity. In effect, there was a using up of the necessary capital reserve in vegetation and soil. The resulting depletion has reduced productivity far below the former sustained yield possibilities. Increases in prices and other charges have added to the burden against the land until it can no longer be carried at a profit. The ability to produce in excess of sustained yield for a considerable period obscured the fact that the land was submarginal for private ownership; but now depletion accentuates the submarginality.

The cultivation of range land completely destroys the natural vegetation, and restoration of the native species is a slow process. As shown elsewhere, such lands in Montana, after 16 years' abandonment had a grazing capacity only 57 percent as great as that on nearby unbroken ranges which were badly depleted by overgrazing. Restoration by artificial means of the abandoned cultivated fields and similarly depleted range land seems to be the only way to reclaim them within a reasonable time. But experience has shown that this will cost from $3 to $3.50 per acre or from $60 to $100 for sufficient range to carry one cow for a year. This investment added to the other costs of production makes private ownership questionable on other than the very best of such land.

Range land which, although not requiring or justifying artificial reseeding, has been depleted to a degree that necessitates drastic reductions in use of livestock for range rehabilitation presents a serious difficulty for retention in private ownership. Where grazing capacity is so far reduced that 5 or 10 acres are required to carry one cow for a month, for example, the cost of ownership may be excessive.

USE OF PUBLIC RANGE CONCEALED SUBMARGINALITY

With public range available for use without charge, many lands have been held in private ownership which could not alone have sustained such ownership. In many instances the owner of a water hole or other strategic key area has been able to control the use of enough range to maintain an economic herd. In some instances where other settlers came in and crowded the range and caused depletion, productivity declined to such an extent that the private

land has not been able to maintain itself. If a reasonable fee is charged for the use of public lands, it is possible that some of the private lands which now control public range areas will not be able to continue returning sufficient profits to the owner to justify their retention.

UNSATISFACTORY SOCIAL CONDITIONS

The unsatisfactory social conditions now prevailing on many private range lands, and which have existed in the past on a still larger scale, are but another indication of submarginality. The toll of human wastage on poor land indicated by ranch abandonment, isolation, and scarcity of schools, medical facilities, and other social opportunities; by the undernourished character of the families; the heavy feed and crop loans which have had to be made by the Federal Government and which have been repaid only in small part; and, more recently, by the high proportion of such rural population on relief, illustrates clearly the inability of low-quality range lands to afford a satisfactory living.

OTHER CONSIDERATIONS

Many other factors contribute in varying degrees to feasibility of such land for private ownership. The suitability of a tract or region to furnish special products such as baby beef and Easter lambs; the amount of supplemental feed which must be used; the expected loss from poisonous plants and other similar causes; and the availability of credit for meeting emergencies are among the considerations. Generally no one factor will decide. It is the total effect of all factors on production costs as compared to returns on a long-time sustained yield basis which gives the final answer to this problem.

Just where the breaking point comes for any given range area is not now known. Economic studies are urgently needed to aid in developing a reliable formula for general application to bring about the orderly adjustment of the ownership difficulties which have been built up and to facilitate retention in private ownership of all land sufficiently productive to redeem fully the obligations which such ownership should entail.

GREATER SECURITY POSSIBLE FROM BALANCED AGRICULTURE

Sudden riches rather than conservative use with a permanent high standard of living have too often been the goal of stockmen and bankers in the development of the range resource. That use on a sustained-yield basis is the only approach to economic and social security for the range country, has received too little recognition.

Sustained use of the range resource means more than conservation of the range. It includes a permanent stabilized system of crop agriculture as well. Throughout the West, as has been shown, the range and the ranches are inseparable and both go to make up the agricultural development. In planning for a permanent high level of use, not only the forage on the range but the supplemental feeds from farm pastures, hay fields, sugar beets, and other farm sources must be considered fully. Only in this way can a balanced use de-

signed to meet the limitations which arise from shortages in feed for critical seasons or years be obtained.

Under such a system the recurring curse of drought years can be largely avoided. The light demand which is made on the grass and supplemental feeds during good years will build up reserves of feed, improve the soil, and provide the haystacks necessary to prevent excessive forced shipment of breeding stock during drought years. Similarly, it leaves to the operator some option as to shipping dates, thus avoiding the annual dumping of stock on glutted markets.

Ranch and range credits are likewise made more secure. A permanent resource and a steady income go far to remove the speculative feature from range financing and therefore justify a lower rate of interest.

Livestock losses have in the past too often canceled possible profits. That this debit entry is largely avoided by good range management coordinated with good ranch operation is no secret. Yet the issue has not been faced squarely. Rule-of-thumb management has not considered this feature. Likewise, the relation of calf and lamb crops to the availability of range forage and to possible profits is too often misunderstood or ignored. A calf crop of 50 rather than 80 percent or a lamb crop of 65 instead of 100 percent or greater is a high price to pay for improper management. The capital investment in the breeding herd is the same in both instances. No business can stand such an unnecessary reduction in units of output and prosper.

Improved breeding has been stressed as a possible way to increase the chance for profit. Good sires have been supplied while low-grade cows and ewes have been culled ruthlessly to get the benefits of quality production. But the full influence of inadequate forage has been overlooked and the benefits of improved breeding have not been fully realized. Investments intended to increase the weight and quality of steers and lambs pay best dividends only when the animals are supplied with ample feed.

Unfortunately, the range country carries a handicap in its location. In this, some areas, such as parts of California, Oregon, and Washington, are exceptions. Elsewhere, a freight barrier must be hurdled if the West is to compete successfully. The one outstanding favorable feature whereby the West can recoup this differential is in cheap range forage. Good-quality livestock ready for the block or commanding a premium price as feeders help to overcome this handicap. Here again, coordinated sustained yield production from the range and ranch is required. Ample cheap feed, fed to good stock, should and will overcome the handicap of distance.

The economic home-unit principle is generally recognized as a sound social objective in distributing the use of the range. It must be appreciated, however, that this does not necessarily mean ownership of all of the range which is needed to run the required number of stock. In fact, the evidence previously presented indicates that forage from leased land or from permits to use public land costs the livestock operator less than does ownership in fee simple, even though in the case of leasing the landowner must pay the excess costs. The minimum requirement should be security in the use of ample range, regardless of ownership, for the number of stock, whether

it be 150 cows or only the few head needed to supplement other cash farm income.

In literally thousands of cases throughout the West it has been demonstrated that with an adequate number of stock, an owned ranch producing supplemental feeds commensurate with the operation, and a permit on a nearby national forest with assurance of enough reasonably cheap range forage, a high plane of living is possible. For more than 25 years this has been the objective, although it has not always been attained, in the distribution of grazing privileges on the national forests. It is to these homes that the radio and washing-machine salesmen rather than the relief agent and social worker make their calls.

Conversely, as discussed in another section, national-forest experience also proves that where numbers of stock grazed per permittee are too low, the sound social values which should flow from the range are not realized. It is in this group of permittees with the fewest numbers of stock that turn-over is greatest.

After a study of 304 ranches in the northern Great Plains and discussion with a large number of ranchmen, M. L. Wilson and associates (*187*) concluded that a strictly economic unit for a cattle ranch in that region must support at least 150 head of breeding cows and should own or control 5 to 7 sections of the prevalent type of dry range. Where there are other major sources of income the number of stock may be correspondingly smaller. The fundamental requirement was found to be consolidation of sufficient land into suitable units of operation. Vass and Pearson (*170*) from a similar study in Wyoming found that those ranches with less than 200 head of productive units were losing on the average 2.79 percent, while the large outfits were making 2.53 percent profits above all costs. The economic unit will vary in size, depending on the location and the type of ranch.

Ranch operations in the sand hills of Nebraska are considered to be among the more stable and successful in the West. Hedges (*78*) reports that the early failure of 640-acre homesteads under the Kinkaid Act of 1904 enabled the stockmen to consolidate holdings into units of substantial size. His study of 47 ranches, varying in size from 1,360 acres and 111 cattle to 29,280 acres and 1,866 cattle, and averaging 6,681 acres, disclosed few forced sales, a small percent of tax delinquency, and a livestock industry close to normal. In this particular locality the constant threat of blowouts in the sandy soil has effectively discouraged overstocking and depletion of the range. The same soil condition has discouraged crop farming other than hay production. Here again plenty of range forage, ample wild or tame hay for winter use, and units large enough for economic production have resulted in a stable livestock industry and a well-balanced agricultural enterprise.

In a recent survey of economic conditions on the Ashland Division of the Custer National Forest, it was found that among ranches with more than 130 head of cattle there were no relief cases, relatively little tax delinquency, and a fairly adequate net income per person. Below 130 head, the social and economic situation rapidly became worse.

Here and there throughout the West, are equally successful outfits operating in large measure on private lands. In each of the

States there is a small minority of livestock operators who have realized the value of protecting their ranges and have profited thereby. They seem to have attained security with well managed ranges and ranches in spite of the handicaps of finances, climate, and markets.

Despite maladjustments, mistakes, and thoughtless exploitation, the agriculture of the West is a splendid enterprise, with its magnificent grain fields and its specialized crops ranging from cotton fields of the Imperial Valley to hardy hay crops able to mature in high frosty meadows. Beautiful towns and cities are embraced by its broad plains and splendid valleys, but surrounding and enveloping all is the range—the original crop that supports and nurtures the West. Where soil is too thin or slopes are too steep, or where the climate is too harsh for cultivated crops or other higher land use, are the grasslands, needing not be sowed—only reaped. Persistent, long-suffering, now badly depleted and eroded, the range is still the essential ingredient of a balanced way of living in the West. Surely, it is not too much to ask that the management of ranges and ranches be so coordinated that greater social and economic security may be enjoyed by future generations.

The Problem of Integration of Western Agriculture

Realization of the full benefits possible from a well-balanced western agriculture depends upon finding some solution of the problems which arise from the maladjustments that have developed from the haphazard use of range and closely related crop land. In reaching a desirable solution, range forage and crop production, the quality of livestock products best suited to a region of comparatively high freight rates, and the effect of all on the social structure and well-being of the West must be considered. Thus the best development of rural life of the West seems to hinge on finding a lasting solution for the following six groups of problems which naturally are closely interrelated.

(1) How, in the light of the cost of restoration, can the very great acreage of abandoned, submarginal dry-farm lands be restored to productive range use in a reasonable period of time?

(2) To what extent and how best can a better balance between the use of range forage and of farm-grown feeds contribute to the solution of overstocking of the western ranges?

(3) How can key areas, such as lambing grounds, water holes, driveways, and holding grounds be restored to a status of ownership and productivity which will insure their maximum contribution to orderly range management?

(4) How far can farm-grown feeds and ranges now used at other seasons be substituted for the badly depleted and insufficient spring range?

(5) How can stockmen generally be made to realize that insufficient feed either on the range or on the feed lot, tends to cancel investments in improved breeding herds by reducing weights, and calf and lamb crops?

(6) What integration of public and private ranges with farms and ranches will aid most effectively in establishing the livestock industry on an economic unit basis whereby a reasonably high standard of living will be assured?

VI. PROGRAM

Most of the factual basis for a constructive program, now possible with the data available and that which could readily be obtained, has been laid in the preceding discussion.

The following discussion outlines the program of constructive action believed necessary in the public interest and most practical in the light of all pertinent considerations, and includes supporting data only where necessary to the main purpose of the discussion. This program is submitted in the belief that the survey of the range situation so far given will fail in its purpose unless translated into terms of the remedial action required of both public and private agencies, the cost, and the time necessary for consummation.

THE PROBABLE FUTURE USE AND OWNERSHIP OF RANGE LANDS

By S. B. Show, Regional Forester, California Region

An attempt will be made here to redefine problems created by maladjustments in form of use and ownership of range lands, the solution of which is vital if the ranges are to realize permanently their possibilities. In addition, the approximate magnitude in terms of area of each separate problem will be estimated; possible methods of action to meet the problems will be examined; and solutions proposed. A summary of the entire estimated task of needed changes in land use and land ownership, and particularly of that part which public agencies should assume, is also a part of the section.

The Problems of Use

THE BACKGROUND

Many forces and movements, the details of which are set forth in other sections of this report, long since combined to create serious maladjustments in the use of millions of acres of western lands. Reviewed briefly, these forces include (1) the tremendous westward surges of agricultural occupation with multitudes of individuals frantically seeking out and competing for every acre of land that conceivably might produce a crop of grain; (2) the comparable mushroom growth of the range livestock industry, with each owner fighting desperately for grass, lest someone else should obtain it first; (3) the spirit of the pioneer (expressed accurately in public-land laws) to gamble with nature, with economic forces, with competitors, to make a quick killing by raiding the stored accumulation of resources; (4) the belief in bigger and better as an end worthy in itself; and (5) the lack of understanding of true public values involved, such as those represented by watershed protection and wildlife range.

When the inexorable process of deflation set in, the penalties began to pile up for unwise dry farming, for exploitative use of ranges, for abuse of vitally important watersheds, for overexpansion and overproduction of grain and animals, for unstable individual and community ventures, for overelaboration of local government and overextension of public debt. Naturally most thought and effort, both public and private, was directed toward maintenance of the status quo, rather than toward frank recognition of basic structural weaknesses in the edifice of western crop agriculture and range use, or orderly and planned means of cure.

Today, as the cumulative effects of the past have been accentuated by drought and depression, it is readily apparent that a truly permanent and self-sustaining civilization is impossible in many parts of the western range country unless a planned effort is made to work out widespread readjustments in use of land. In these read-

justments, the problem which stands out most clearly, as other sections of the report show, is that of restoring uneconomically and destructively cropped lands to range use.

THE PROBLEM OF UNECONOMICALLY CROPPED LANDS

On a large area of level or gently sloping lands, dry farming has been attempted and has proven uneconomic. The illusion that dry farming had an almost unlimited field for economic application arose from a combination of using virgin soil, enjoying abnormally favorable climatic conditions, and selling in markets that could absorb whatever was offered. The pressure of the World War, which made production through dry farming not alone an opportunity for profit, but a patriotic duty as well, inevitably resulted in breaking with the plow millions of acres which had been the cream of the western range lands. Great areas of the short-grass plains east of the Rockies, in the western Dakotas, in western Nebraska and Kansas, in eastern Montana, in central and western Texas, that once were excellent range, are now unneeded and uneconomic cropland. So, too, are large areas in central Washington, central and eastern Oregon, and in Idaho and Utah. Furthermore, the range values of these lands are gone and can be restored only at some expense and waiting; the crop values are negative.

In addition to these large areas of dry-farmed wheatlands, the problem involves hill farms in the central valley foothills of California, where only the most temporary combination of favorable climatic factors, virgin soil, and market demand could make crop use a success, and where cultivation has resulted in erosion, with depletion of the soil, and damage to watershed and other public values.

Most of this type of land was excellent range, most of it is definitely uneconomic for crops, and most of it can fulfill its true and permanent economic function only if restored to range use. In all such instances, systematic working out of this problem is highly important to the range-livestock industry, not only because the forage-producing capacity of the lands is high, but because it will restore to use many natural range units unencumbered by a patchwork pattern of cropped and fenced rectangles.

THE AREAS TO CHANGE FROM CROP TO OTHER USE

The Resettlement Administration has made preliminary estimates of the acreage of land in farms within certain problem areas, much of which should be encouraged to change to noncrop use, and has developed an initial purchase program. The total area of these project farms within the 17 range States is 44,413,000 acres. Of the total, about 2 million acres are in forest belts and should revert to timber production. Of the remaining 42 million acres, about 11 million are croplands and 31 million are range land. Nearly two-thirds of the cropland, or 7.2 million acres, are regarded by the Resettlement Administration as permanently submarginal for crops.

The program of the Resettlement Administration involves purchase of lands of this type, as the most effective means to bring

about desirable changes in use. Thus existing public policy contemplates public ownership, at least, as an intermediate step, for such lands.

Outside of these problem areas a large acreage of land has been cropped at one time or another, and while much of it is no longer under cultivation, it is still in private ownership and may be cultivated again. Part of this has already been abandoned because of low productivity. At least 8 million acres of these scattered tracts of croplands are in such condition that public ownership is the logical outcome.

General information developed through the present studies indicates that the area of submarginal croplands of these types which will need to be taken over by public agencies, including both present problems areas and other scattered units, will reach a minimum of 15 million acres.

THE PROBLEM OF COORDINATING RANGE USE WITH THE NATIONAL AGRICULTURAL-ADJUSTMENT AND LAND-USE PROGRAMS

The center of gravity of crop agriculture lies in the Middle West. Whatever changes in production are worked out there from a planwise approach to the national crop-adjustment problem, will automatically affect other regions which now produce similar crops. If, as is possible, lands devoted to crops are changed to pasture, with a resulting increase in production of meat animals, the number of meat animals required for estimated consumptive needs will be less from the western range country than in the past or the present. A reduction of this sort might be absorbed by the generally lighter stocking of the ranges that, as this report shows unmistakably, is essential to preserve the range itself. Or it might be absorbed through nonuse of certain range areas; or by increased production of supplemental feeds and a shorter season on the range; or by a combination of lighter stocking, nonuse, and shorter grazing season. The general agricultural crop adjustment plan is not now complete and authoritative enough to justify any final conclusion, but it is necessary to recognize that changes in use of range lands over and above those suggested in this report may well result.

OTHER USE ADJUSTMENT PROBLEMS

The report indicates that, on considerable areas, outstanding public values in watershed protection and range for wildlife are deteriorating through overuse by domestic stock. It is possible, and indeed probable, that on part of this land nonuse by domestic livestock may be required, although insufficient detailed work has been done to furnish a final and conclusive answer. In addition, certain privately owned lands are needed for rounding out natural range units within and adjacent to the national forests.

The entire question of the most effective form of ownership to protect public values on range lands of these classes, whether involving nonuse or not, will be examined later in this section. It can best be seen as a whole, rather than through separate study of the parts.

The Problems of Private Ownership

OWNERSHIP PATTERN—CAUSES, EFFECTS, AND RESPONSIBILITY

Many forces, set forth in detail elsewhere in this report, have combined to create a crazy-quilt pattern of range-land ownership, ill-adapted alike to the requirements of the range livestock industry and of the public. These forces include (1) ill-advised public-land laws, well adapted for the humid eastern United States but unsuited for the arid range country; (2) the struggle by individual stockmen for security through ownership of the ranges; (3) forces of competition within the range-livestock industry, which compelled land ownership; (4) cumulative depletion of the range with reduced grazing capacity; (5) growing and more complex pressure of public needs on private rangelands; (6) excessive unit investments in range land, forced by competitive bidding against other stockmen and dry farmers; (7) too easy credit—a temptation to unwise investment in rangelands at prices above their true value; (8) high taxes caused by overelaboration of local government; (9) high prices set by State or Federal laws for sale of State lands; (10) high interest rates; (11) lack of knowledge of true grazing capacity and true value of low-grade lands; and (12) speculation in range lands.

Any ownership pattern resulting from the unplanned and undirected operation of these contradictory forces must necessarily have far-reaching effects.

Merely to list the undesirable consequences which this ownership pattern causes or helps to cause is to indicate the complex and far-reaching nature of the ownership problem. Among the effects, discussed elsewhere in the report, are depletion of the range itself; widespread overcapitalization, which coupled with range depletion makes successful operation difficult; uneconomic and unbalanced individual livestock operations, in turn leading to unstable communities; shifting and unstable private ownership; a vicious circle of tax reversion, resale to private ownership, and more tax reversion; another of foreclosure, resale, and more foreclosure; automatic ignoring, owing to exploitative use, of public values inherent in the lands; difficulty in management on the range; creation of an enormous task of range rehabilitation, to restore forage values, involving both cash outlays for reseeding, and great reduction in stocking; and creation of an additional task of recapturing watershed values, involving cash outlay for erosion control as well as reduction or elimination of stock.

The net effect of range depletion and the high cost to restore forage and public values is to place a difficult or impossible task before many private owners; that is, to make additional expenditures in the face of decreasing returns.

Superficial examination of the outward and visible facts of range depletion, unworkable ownership pattern, and widespread overcapitalization of the range livestock industry may readily lead to the conclusion that the maladjustments now so evident are due primarily to the lack of knowledge or acquisitiveness of those engaged in the business. That stockmen might have helped to avoid or to solve some of the present problems in their early phases is true. A more conservative pattern of business management; less gambling on the

big year; less reliance on mere numbers of stock owned; more careful attention to the range as part of the productive plant—all these would have helped. And it is far from clear that group action by stockmen has focused as effectively as it might on constructive legislation for public lands, and on the use of public credit to stabilize the business on a conservative basis. But study of the long historical process which has finally resulted in present-day difficulties shows that public inattention to the range resources and to the civilization built around it, has also underlain the whole process.

For example, until 1934 no start was made by the Federal Government to manage the public domain constructively. Even then only about one-half was reserved, and on that half eventual passage to private ownership was still contemplated. This action was delayed for a third of a century after the stockmen users themselves had recognized the need for Federal reservation and management. It was delayed for a quarter of a century after a successful system of range management on public lands in the national forests had demonstrated its worth.

Not only that; in other respects as well, both Federal and State Governments have failed to comprehend the stockmen's difficulties and take obvious steps to enlighten them. The land-disposal laws of the Federal Government still stand on the statute books, decades after their inapplicability to arid and low-grade western range lands was made clearly evident. Over half a century ago it was recommended that public lands in the arid regions be passed to private ownership in economic-sized units, adequate to support a family. No such provision ever became a law. For decades the range livestock operator paid excessive rates of interest on borrowed money, and belated public action to protect him came in the main after he was committed to debts that were ruinous. The producer has always been at the mercy of the buyer in the major marketing centers and even today the public protection and assistance afforded him seems none too complete. Public agricultural-research agencies, concerned primarily with the problems of crop agriculture, have paid relatively slight attention to furnishing the indispensable factual basis for more intelligent private-range management. Some States, through failure to manage their range lands constructively and through unjustified prices for their lands, have added to the problem of private ownership, and States and counties as well, through building costly structures for local government, based on high tax rates, and through repeated repassing of tax-reverted lands to private ownership, have further contributed.

WHY SHOULD THE PUBLIC BE INTERESTED?

A simple listing of these errors of omission and commission by the public furnishes in itself justification for public interest in and attention to the whole problem of the range resource and the ownership problem which is a part of it. Even though recognition of the problem is belated, the most elementary considerations of equity between the Government and its people dictate an attempt to repair damages to which public neglect has contributed.

But there are other forceful and affirmative reasons for analysis of the ownership problem.

THE PRIVATE OWNERSHIP PROBLEM IS REAL AND NOT SUPERFICIAL

Although depression and drought have accentuated and thrown into sharper focus the problems of ownership of range lands, drought and depression did not create the problems. Nor will their absence remove the problems. Earlier sections of the report have sketched the history of the unplanned and uncontrolled development of the range livestock businesses, of western crop agriculture and its dry-farming phase, of the consequences of the operation of the public-land laws, of the unwieldy and top-heavy capital investment structure forced on the individual stockman by competition for range, all of which tended toward overstocking and resultant range depletion.

What happened is clear enough. In many cases—perhaps extreme ones—an individual started with a small herd. He had to acquire a home ranch to produce supplemental feed, meanwhile depending on public range for part-time feed. The investment in the ranch led to increase in his herd. Other owners competed for the public range he had enjoyed. His only solution was to acquire range lands of his own, that he might be assured of essential feed. He borrowed to acquire the range. Taxes and other costs were added to his cost of production. He moved in an ever-climbing spiral of more stock in an effort to meet his fixed costs, thus heavier stocking, thus poorer condition and lower selling prices, thus depletion of his productive capital—the range.

Where prices at which States were required to sell range lands were fixed, or where the price for range lands was fixed by competitive bidding for dry-farming use, the stockman paid a price bearing little relation to the true value.

He was far from being a free agent. He would have been much better able to operate profitably without the load of range land, thus to reduce his fixed investment and annual costs and thereby increase the proportion of his total capital investment represented by his breeding herd. But competition drove him to attempt self-protection unwisely through ownership.

This whole process, which has operated in many places and for many years, has an inevitability, once started, which small remedies and minor tinkerings can hardly alter. The individual is caught in a trap and only with difficulty can halt or reverse the process that has engaged him therein, however clearly he may recognize that he is committing economic suicide; that doing things obviously against his own interest, such as overstocking and depreciation of capital stock—the range—can lead only to one end. When lands are handled primarily under pressure of real or apparent immediate financial needs rather than as a permanent productive instrument, then clearly a real problem of private range-land ownership exists.

By no means all stockmen have been caught in the process sketched above. Many were sufficiently free of compelling financial pressure so that they might have managed their ranges more conservatively, but the evidence is that few have done so. Regardless of ability or inability to manage conservatively, the end result of overstocking has been range depletion, one of the major reasons for present ownership problems.

CONTINUED WASTAGE OF BASIC RESOURCES IS INTOLERABLE

In any event, an attempt to weigh the relative responsibility of private owners and public agencies is not the issue, because the private-land problem is one affecting not alone the individual but the public as well. For public policy can hardly tolerate continued drifting toward eventual destruction of the range resource, around which the economy of much of the West is built.

The mere fact that the cash value of the forage produced per acre per year from the lower grade range is not high, does not obscure the fact that with hundreds of millions of acres involved, the aggregate value is high. Even where destruction of the range resource does not affect other values such as watershed, game, and recreation, preventable destruction of a basis of national wealth clearly cannot be accepted. Over and above all other considerations stands the fact that the public must, in case of need, step in to protect itself against loss of a basic source of primary wealth.

THE SOLUTION MUST BE A JOINT UNDERTAKING OF PRIVATE AND PUBLIC OWNERSHIP

Since the present difficulties of too much low-grade land in private ownership, and too little attention to much of the land in Federal, State, and county ownership, have developed largely through lack of any or of the proper public action, clearly the solution must come through a reconsideration of the existing ownership pattern.

This study has established ample evidence that the whole job of ownership and constructive management of the range area of 728 million acres is a partnership undertaking. The conclusion is here advanced that primarily the public function is to help to create conditions under which private ownership of the better range lands can continue, but with a more workable chance to function successfully than in the past. Although in many places private ownership heretofore has conserved neither the public values of watershed and wildlife nor the private value of the range, it by no means follows that all private ownership has so failed, nor that with more public effort to determine its true field, private ownership will not be more able to conserve both private and public values.

The questions then become: (1) What form should the unscrambling of the ownership pattern take, in order to give private ownership a more workable chance? (2) What means of public action are available for this broad purpose and which of these, in the light of experience, is likely to be most effective?

THE POSSIBLE MEANS OF PUBLIC ASSISTANCE TO STRENGTHEN PRIVATE RANGE-LAND OWNERSHIP

Problems of private range-land ownership, particularly of lower-grade lands, revolve largely, though not wholly, around financial difficulties in balancing costs and returns within the competitive structure of the business.

THE POSSIBILITY OF REDUCING CARRYING COSTS

Of the factors bearing on the chance for success of the range-livestock business, two stand out as of major weight in the financial overload now carried by many operators. They are the high investment per acre, when compared to true income value of low-grade lands, and the high level of local taxes on such lands.

Reduction in costs of local government has long been recognized as desirable and studies have shown unmistakably that consolidations of units and functions could increase rather than decrease local governmental efficiency. But such rigid things as local pride, intrenched bodies having taxing powers, existing laws, outstanding bonds, resistance to change, and the growing tendency for State and Federal Governments to take over county functions and obligations, have combined to prevent many fundamental changes in local taxation.

Altogether it seems unlikely that progress toward solution of this great problem, which affects all private lands and property, will be rapid enough to be effective in solving the immediate problem of lower-grade private range lands. And with existing commitments, it is far from sure how far reductions can go.

POSSIBILITY OF INCREASING CAPITAL INVESTMENT IN RANGE LANDS

That capital investment per acre in range lands is often excessive is as evident as that local taxes are often too high. In both cases a heavy deflation is needed to give private ownership a fair chance at success. But the forces resisting deflation to a workable basis are powerful, since individuals, like local authorities, tend to hang on to the end and attempt to maintain an unworkable set-up. Even though an eventual loss must be accepted, in the one case by local government, in the other by individual owners, the process of deflation is slow and irregular. While it is under way, the basic resource—the range—will necessarily continue to suffer.

So without attempting to say that these major problems affecting private range-land ownership cannot or will not be finally solved in a way to improve the opportunity for successful private range livestock operation, it may be concluded merely that an enormous problem of rebuilding exists, that a prompt and adequate attack is needed, and that methods of attack should be judged first of all by their immediate applicability.

POSSIBILITY OF ADDITIONAL PUBLIC ASSISTANCE IN CREDIT AND MARKETING

The range-livestock business has been subject to various hazards of which excessive costs of range-land ownership is only one. The Federal Government has already recognized, through creation of the Farm Credit Administration and its subsidiaries, the need of livestock producers to be freed from the excessive interest rates of private banking, and to have access to credit better adapted to operating needs. This venture into the field of public assistance is already a going concern. In the industrial problem of marketing, also, there is a field in which public assistance is clearly desirable to ensure that the producer is not wholly at the mercy of agents

and packers. But in neither field does such assistance aid greatly in solving the problems of private ownership of low-grade lands or of those possessing high public values.

POSSIBILITY OF PUBLIC ASSISTANCE THROUGH INCREASE IN RESEARCH AND EXTENSION

Another section of the report discusses in detail the unsolved problems affecting range lands and the range livestock business, and proposes a more adequate research program to redeem this part of the public's responsibility.

A complete program will, over a period of years, greatly assist operators in the conduct of their businesses. But research and extension can hardly solve immediate and pressing ownership problems.

POSSIBILITY OF REGULATION

Regulation by law to compel the individual owner to manage his land constructively and conservatively, so as to preserve both forage and public values, might well be effective if mistreatment of land were due primarily to ignorance or willfulness and the owner were financially able to do the things required by law to remedy abuse. But the private range-land problem was largely created and continues to exist precisely because many owners were not wholly free agents, financially able to manage constructively. As a general means of effective public action, regulation by law can hardly be looked on with confidence. Quite possibly in the long run, when private ownership of range lands is on a far more stable basis and most land is managed to preserve its values, regulation may be a useful tool to bring a stubborn minority into line with the general level of private ownership; but at present any general attempt at regulation would almost certainly be premature. To be effective, the legal requirements would include the very things private ownership is in large measure financially unable to do.

POSSIBILITY OF SUBSIDIES

Subsidies, on the contrary, would give to the private owner some cash return in recognition of the fact that many range lands are vested with definite public values, which it is vital to preserve. The giving of a subsidy and the acceptance thereof constitute in effect a contract between the public and the owner, in which the recompense for public expenditures is obtained in the form of better land condition.

In whatever form the contractual quid pro quo appears, its existence is implicit. Whether the Federal agency determines in detail the things to be done, and checks performance, or whether it merely assumes that the subsidy will automatically cause the desired things to come to pass, the prime purpose in any event is to cause to happen certain things—desirable in the public interest—which otherwise would not happen.

The problem of public assistance or subsidy to owners in management of their land is inherently complex and elusive. A variety of Federal-aid ventures have long been in operation, including the

highways, the agricultural colleges, private and State forest lands, and others. In all of these one common denominator appears: The Federal Government deals with and through a strong professional State administrative organization, so that the relationship is between single units of Federal and State Government and is on a professional basis. That there may be a place for Federal aid as a means of helping to solve problems of private range-land ownership is clear. But the barriers to immediate adoption of this as a general formula are evident. At present there are no State governmental organizations, professional in character, to deal with in the field of range-land management. As an immediate step, the Federal agency would necessarily deal directly with a multitude of individual owners, thus setting up a relationship undesirably ignoring the States. Certainly adequate State agencies could be developed over a term of years, as the States assume their part in the whole range-management undertaking, but such a process takes years, as experience in other fields shows.

The stockmen are organized in trade associations, varying in strength and character. But to deal with the livestock associations would be to expect a high degree of self-regulation, since the return to the Federal Government to offset the aid would be in the form of better condition of range lands. This could be obtained only by improving land-husbandry practices and the enforcing agency—the association—would consist of landowners who were regulating themselves. The record of self-regulation in other fields hardly justifies a strong conviction that it would be more effective in this. Thus, the inherent weakness of the subsidy as a weapon of attack on this sort of problem, and the innate defects of self-regulation seem entirely clear.

The need for subsidy arises because the individual landowner, in failing to do things in treatment of his property that it is in his own interest to do, has finally done injury to the public interest. In this situation public aid is justified, usually because the owner is in a more or less desperate situation in his own business. It comes to him necessarily as individual assistance, and unless it is coupled with tight regulation in use of land the results are unlikely to be satisfactory from the public viewpoint.

POSSIBILITY OF PUBLIC ACQUISITION

The record of both the Federal and State Governments in constructive management of range lands is decidedly inconsistent and spotty.

The Federal Government has for 30 years, through the national forests, conducted a large-scale demonstration in range management on public lands, during the course of which many constructive developments of major consequence have been worked out through trial and conflict, and the application of improved management developed by research and experience. And though the record of accomplishment is far from perfect, national-forest range management has, on the whole, been markedly successful; the mechanism and much of the technique have been worked out; and the development of a professionally competent and resident organization has set a workable pattern for similar public ventures.

But an even larger area of Federal range land—the public domain—has until very recently drifted with no pretense of administration, and has paid in depletion the penalty of long-continued neglect. Even now but half of this Federal property is in process of being placed under administration.

The Indian range lands, too, have suffered severely through overgrazing, though supervised by the Federal Government. It is only recently that more constructive policies and plans have been developed, looking to rehabilitation of this resource on all these lands, though some have been well handled for years.

Thus the record to date of the Federal management of range land is part reasonably good, part bad. The national-forest experience at least demonstrates what can be done and shows it to be within the capacity of the Federal Government to do an effective job.

The record of the States in management of their range land is on the whole discouraging. The general desire, largely set by Federal grant laws, to obtain immediately cash income and the handling of lands by State bodies having a real-estate point of view, have meant exploitative use and range depletion on most State lands. Effective ownership and management of low-grade range lands, and those possessing public values, usually demands cash outlays as investment or administrative cost which may not be immediately returned through severance charges for forage.

In its financial ability to make the expenditures required to do the job thoroughly, the Federal Government has the advantage of outstanding financial strength. It has also unique and far greater opportunity to reimburse itself over a period for capital investments required to develop the range property and for current costs of administration, than does any other kind of ownership, private, State, or county. For any source of wealth, such as the range, produces commodities which, between the point of production and the final consumer, pass through the hands of many businesses. Each of these is subject to the operation of the corporation- or income-tax laws, and some part of the profit created at each step of the producer-to-consumer chain finally finds its way to the Federal Treasury. So, in addition to a direct and equitable severance charge for forage, which the Federal Government can collect in common with other kinds of ownership, and which in effect can be used to help defray costs of ownership and management, the Federal Government through other and indirect means can reimburse itself and even make a profit as a landowner.

Some States have already adopted the income tax as a revenue-producing mechanism, and so enjoy in part the same opportunity as the Federal Government to obtain revenue from each step in the progress from production to consumption. But, since a large part of the products of the range finds its way into interstate commerce, no State can well be on competitive equality with the Federal Government in this respect.

Thus, except where costs of range-land ownership are grossly above the direct severance charge, the Federal Government, in particular, in preserving range values through ownership and constructive management, accomplishes several things. In the narrow and restrictive sense of repaying its own Treasury for costs, it can usually come

out at least even. It preserves a primary source of wealth, both of forage and of public values—part of the physical basis for national self-support. In maintaining unimpaired a base capable of supporting population, it prevents to that extent the piling up of unemployed and relief cases, and in the end avoids the inevitable public cost of supporting directly such people.

Public, and particularly Federal, ownership thus appears to be on the whole the most effective weapon of attack on the problems of private ownership of low-grade range lands, and of deteriorating range lands having high public values.

Adoption of this working method is, moreover, simply an expansion of existing policies, long recognized in undertakings of the Federal Government. The land-purchase program of the Resettlement Administration is dealing with submarginal dry-farmed lands, with eroding hill farms, and with depleted range lands. The purchase program for national-forest purposes has recently recognized depleted range lands with high watershed values as eligible for operations of the Clarke-McNary law. In both cases there is recognition that the public must protect both itself and its citizens as property owners, where the latter are unable to do so.

A balanced judgment of the efficacy of public acquisition and management as an immediate means of attack on the ownership problems must take into account both favorable and unfavorable considerations. On the one hand, public acquisition strikes directly at the problems, is established as a function and operation of government, and management of public land has been successful on the national forests. On the other hand, an adequate program has been established neither by the States nor the Federal Government, the vital question of jurisdiction over Federal range lands is not yet settled, and the record of public range-land management is spotty.

But on the whole, if used to supplement other desirable public action, public acquisition has a large and irreplaceable part in any comprehensive attack on the range-land problem. In other words, as public acquisition frees private ownership of lands unsuited for that status, even with public assistance, the better lands remaining in private ownership can be more readily managed in a constructive way. Public assistance on them should then be more effective.

In this conclusion, no question of philosophical or political principles or dogma is involved. It is simply a case of a realistic approach to the actualities of a situation, using the most effective means of action available. Public land ownership is not a panacea for all the ills of the range-livestock industries or of range depletion, but it is one method of attack.

INADEQUACY OF DATA PREVENTS ACCURATE DETERMINATION OF SIZE OF PROBLEMS

The processes which have resulted in present problems of private range-land ownership are clear enough. And the reality of the problems is evident. But to determine where, how much, and what lands are unsuited for permanent private ownership and management, and which should therefore come into public ownership is a far more difficult matter. Prior to this study, no comprehensive

attempt was made to appraise the range-land problem as a whole, and even the basic facts as to areas, distribution of ownership, carrying capacity of major areas and types, are available only as approximations. Studies of the economics of the industry as a whole, and of the economics of private range-land ownership in particular, have been fragmentary, made on different bases, and at different times. Indeed, a large part of the effort to obtain facts applicable to private lands has been devoted to the animal-husbandry phases of the range livestock business, rather than to the land-management or economic phases which have centered on public lands. The possibilities of improving the opportunity for business success of range livestock operators through various forms of public and private action have been but partially explored.

Thus, the attempt here made to move from the general to the particular, and to approximate the size and location of the future range-land ownership distribution, should be regarded as simply a first trial, subject to refinement as more detailed surveys and studies of the range country become available. That a basis different and superior to the one here used could be developed is quite possible. But with the scanty information available, the basis adopted has appeared to give at least an approximation of the job ahead. This phase of the entire study is a first exploration, and necessarily should be followed by a great deal of further study.

Estimated Shifts in Range Lands Submarginal for Private Ownership

One problem, as has been said earlier, concerns low-grade lands, already depleted, where the costs of ownership and of restoration of productivity make continued destructive exploitation under private ownership probable or inevitable, and permanent and constructive private ownership doubtful or impossible. These are lands where private ownership cannot be expected to do the job of restoration and constructive management. On such lands, in the main, carrying costs in the form of taxes and interest are disproportionately high when compared to the true income value from the lands. Thus a vicious circle of overstocking, resulting depletion, and then continued overstocking has often appeared to the owner the easiest way out in his efforts to obtain feed at a cost he can afford. Unaided escape from the circle, requiring reduction in stocking and cash outlay for range restoration, is unlikely.

The Basis for Estimating Needed Shifts From Private to Public Ownership

The section on financial handicaps has shown that range-land ownership is one of the major elements of the capital-investment structure which contributes to financial rigidity of the business, and may be so high as to reduce the proportion of the total capital investment represented by breeding herds to a point that losses instead of profits follow. It has shown, too, that the ratio between investment in breeding herds and other capital items, largely land,

has decreased from 1 to 1¼ in the nineties to almost 1 to 6 today. It is perfectly clear that the frozen investment in land has become so excessively high that an impossible burden of producing cash income is placed on the breeding herd. Investment in range land is the element of the capital structure most readily affected by public action.

The absolute or proportionate part of the total capital investment which can safely be in range lands depends, it is evident, on the relative competitive position of the individual livestock business. Thus, for example, too large or too small operations within a given region, all else being equal, are at a competitive disadvantage with businesses of a size that experience has proved to be most efficient. Again, all businesses within a region may have a competitive freight differential against them in reaching major markets.

So the key to an appraisal of how much range land private ownership can carry successfully lies not so much in a consideration of the land itself as in the present relative regional opportunities for profitable range-livestock businesses. That is, the more favorable the chance for the business as a whole, the greater the chance of the operator to own and manage his own range; and conversely, the less favorable his chance as a whole the greater is the need for public ownership of the range as a means of stabilizing the business and placing it on a competitive parity with other regions.

Public action in furnishing credit and marketing facilities blankets the range region, with equal service in each part of the whole. But from this approach to a determination of the true field for additional public ownership of range land, there will necessarily be differential action in the several States or regions.

In breaking down the problem of opportunity for profit in the range-livestock business at least five groups of factors must be considered, covering forage production, general production costs, feed costs, stability of the ranch unit, and marketing. The first group of factors, in detail, includes:

1. The average volume of forage—that is, whether the number of acres per head is large, medium, or small.

2. The condition of the range and cost to rehabilitate, both varying greatly in different types and regions.

3. The susceptibility to mistreatment—whether the range type can or cannot withstand punishment.

4. The usual forage composition—whether the feed is adapted to turning off fat stock and whether the range is suitable for different classes of stock.

5. The dependability of forage—whether there are wide fluctuations in different years because of climatic variations.

6. The frequency of severe winters and severe drought—whether saving of large quantities of feed is necessary as a safeguard against heavy losses.

7. The possibilities of yearlong range operations—whether a long, medium, or short period on the range is possible.

The second group of factors dealing with costs of production in other than feed items includes:

1. The investment per head in land and improvements—the base on which interest must be earned.
2. The general level of indebtedness—the degree to which immediate financial needs control.
3. The general level of local taxes.
4. The cost of management on the range—whether intensive handling and considerable investment in range improvements are required.

The third group of factors, having to do with the cost of feed, are:

1. The cost of leased range—the degree to which the operator is at the mercy of the landowner, and accessibility of the range.
2. The cost of supplemental feed, whether produced on home ranch or purchased.
3. The natural set-up for balanced operation—whether range lands best adapted for different seasons of use are in balance with each other in quantity and location.
4. The possibility for balance with agricultural operations—whether byproducts of crop operation are available.
5. The dependability of tenure of owned or leased ranch and range.

The fourth group of factors, dealing with efficiency of livestock operations, includes the following four:

1. Average size of operation—whether too small, too large, or within the zone of greatest efficiency.
2. The general level of skill of operators, including the degree of owner attention to the business.
3. The general level of losses on ranch and range from various factors.
4. The degree of attention by research agencies to problems of range-livestock businesses.

The final group of factors is concerned with two important details of marketing and transportation:

1. Whether the range is accessible to a single or to more than one major market.
2. Relative freight cost compared to other producing region.

A summation of all of the above factors determines the relative advantages and disadvantages of different range types.

The results of many studies of the range-livestock business supplemented by the knowledge of men thoroughly familiar with the entire western range country have been combined in rating the relative favorableness of the nine major-range types. Each factor in each type was rated as above average, average, or below average in favorableness. For example, nearness to major markets rates as above average for the tall-grass type, below average for the sagebrush-grass type, and about average for the Pacific-bunchgrass type.

The number of pluses, minuses, and plus-minuses totaled for each type, gave a relative weighted average. The tall-grass type, for example, showed 17 of 22 factors as favorable, and one as average, whereas the southern desert-shrub type had three factors favorable and one average.

RATING OF OPPORTUNITY FOR PRIVATE MANAGEMENT IN DIFFERENT FORAGE TYPES

The results, expressed as a single figure of relative favorableness for the different range types, serve to separate the types into four groups, as follows:

	Percent
Most favorable:	
Tall grass	76
Short grass	65
Moderately favorable:	
Pacific bunchgrass	45
Woodland-chaparral	43
Semidesert grass	40
Slightly favorable:	
Pifion-juniper	27
Sagebrush-grass	23
Least favorable:	
Salt-desert shrub	17
Southern desert shrub	12

These ratings and groupings are necessarily approximations. They do not and cannot give more than a broad picture of the absolute degree of opportunity for private range management in any single type, but they do give a fair approximation of the comparative advantages of the several types.

This plan of rating and, therefore, its results are based on the present situation. In utilizing the results as a criterion for judging the future place of private range-land ownership, the assumption must be that the rating of the individual factors—which combine to make the total rating—will not alter markedly. That this is a fair assumption is evident if the 22 factors enumerated above are classified into two groups—(1) the fixed factors dealing with the character, geography, and relationships of the range itself and (2) those dealing with political and economic condition and relationships. If that is done, the latter or theoretical group comprises only five factors—the investment per head in land and improvements, the general level of indebtedness, the cost of leased range, the dependability of tenure, and the general level of local taxes. Of these five, the two most important—investment in land and improvements, and level of local taxes—have already been characterized as likely to alter but slowly. The present situation, therefore, as regards these is justified as part of the basis for the rating of private opportunity for successful private range management.

The significance of the figures in the above tabulation, as a guide to the solution of the problem of future distribution of range-land ownership, is readily apparent from the findings of the section of the report dealing with financial handicaps of the range-livestock industries. A major conclusion of the analysis was that since private ownership of range lands decreases the proportion of the total capital investment in the breeding herd and thereby increases the financial rigidity of the business, the justifiable ownership of range land depends primarily on the business success of the venture as a whole.

It follows then that in the tall-grass and short-grass types, rated as 76 percent and 65 percent favorable for private range-livestock operations, the individual operator can reasonably be expected, since

he clearly has the opportunity, to own and manage constructively the great bulk of the range land he uses.

No definite and authoritative guide exists that will solve the problem of just what proportion of the total range in these types is adapted for private ownership. In a comparable study of the ownership problem of forest lands (A National Plan for American Forestry; Future Distribution of Forest Land Ownership (*154*)), it was found after careful analysis that in the most favorable region for private forestry about 15 percent of the total land either was required for public purposes or was enough lower in quality than the average for the region so that it was ill-suited to private ownership.

This conclusion for forest lands favorable for private forestry cannot of course be automatically applied to range lands. In each of the two types, however, it may be assumed that there is a zone or band, ranging from perhaps 5 to 25 percent within which the true scope of public ownership lies. Part of the tall-grass type, for example, is on the breaks of several rivers and so is ill-adapted to private ownership. That the lower limit cannot be 0 percent is evident because some lands will certainly be needed for wildlife, or other public purposes. That the upper limit cannot be high is clear because the lands have on the whole demonstrated their suitability in private ownership, and because no large areas of critical watershed lands—relative to the acreage of the types—are found in this study. Further detailed study may show that 15 percent of the total type area is too high or too low. It is used here simply as an approximation of the part of the whole type probably destined for eventual public ownership.

At the other end of the scale of favorableness, the southern desert-shrub type, rating 12 percent, is clearly one within which private ownership of range land is financially justified to but a slight extent. With a generally unfavorable business opportunity, extensive investments, and annual costs on range lands would tend strongly to tip the balance toward losses rather than profits. But even in so generally unfavorable a region there are areas so much superior to the regional average as to be adapted to private ownership. Favorable location, or better than average soil, can readily make this difference. Here again the proportion of the whole type that private ownership can handle cannot be fixed definitely. In the least favorable forest region it was found that 10 percent of the total now privately owned was suited for permanent private ownership. Here a band of perhaps 5 to 15 percent of the total range type area will be likely to remain in private ownership. Lands needed for home ranches and islands of exceptionally high productivity would probably account for 10 percent of the type area, and that proportion is adopted as an approximation for the least favorable group of range types.

For the type groups of intermediate opportunity it is assumed that 40 percent of the present total private range land in the Pacific-bunchgrass, woodland-chaparral, and semidesert-grass types might eventually be acquired by public agencies, and 65 percent of the piñon-juniper and sagebrush-grass type.

Since this method is only an approximation, the results will surely be modified as more detailed surveys and economic studies of private ownership are made. But the approximation indicates, if nothing else, that very large job of recapture through purchase which confronts public agencies, and is adequate justification for beginning an acquisition program.

PROSPECTIVE PUBLIC ACQUISITION

The areas of private land thus estimated as involved in future ownership distribution are shown in table 68. Open forest (43,568,000 acres) is omitted from this table since probably the highest potential use of most of these lands is for timber production; estimates of future private and public ownership of commercial forest lands have previously been published; and such of the open-forest grazing type now in private ownership as should be publicly acquired is needed for administrative purposes as indicated later in this discussion.

TABLE 68.—*Present areas and prospective future ownership of present private land in major range types*

Range type	Present area private land	Area likely to remain private	Prospective shift to public ownership
	Thousand acres	Percent	Thousand acres
Tall grass	17,271	35	2,000
Short grass	148,144	85	22,000
Pacific bunchgrass	35,913	60	14,000
Semidesert grass	48,438	80	10,000
Woodland-chaparral	10,040	60	4,000
Pifion-juniper	20,000	25	15,000
Sagebrush grass	34,701	35	22,000
Southern desert shrub	10,048	10	9,000
Salt-desert shrub	8,262	10	4,000
Total	332,976	66	113,000

Even though the 113 million acres indicated be too high or too low, clearly the range-land acquisition program should be a large one, if it is measurably to meet the public responsibility of caring for lands unsuited for permanent private ownership. Even the carrying out of the suggested program would leave to private ownership nearly two-thirds of the western range lands now privately owned. A rough check of this approach is possible by comparing the indicated percentage for private range land in each type group estimated to remain in private ownership, with the percentage of all land in the type which has passed to private ownership. The comparison is given in table 69.

TABLE 69.—*Comparison by type groups of percentage of all nonforest range land now in private ownership with percentage now private estimated to remain private*

Range type group	Land now privately owned	Present private land estimated to remain so	Estimated private land in entire U.S.
	Percent	*Percent*	*Percent*
Tall grass	76.2	85	64.8
Short grass			
Pacific bunchgrass	65.4	60	60.2
Sagebrush grass			
Woodland-chaparral	32.4	38	11.4
Pinon-juniper			
Sagebrush grass	20.5	10	2.4
Southern desert shrub			
Salt-desert shrub			
Average	32.6	35.9	24.9

This comparison shows at least that the present level of investment in range lands is highest in the types where opportunity for private enterprise, and hence safety of owning range, is highest. Conversely, investment in range lands is lowest where private opportunity is lowest. So, in general, the experience of private range-land ownership checks with the findings of the rating plan as to relative favorableness of the several broad range types.

Data on present grazing capacity and percentage of depletion from virgin condition of range-type groups (table 70) also bear on the question of relative suitability for private ownership, because of the widespread tendency to tax lower-grade lands in a given area at the same rate as better lands. Thus the poorer tracts tend to carry disproportionately high costs. The percentage of depletion obviously reflects the need for reduction in stocking and for cash outlays to restore forage values, both of which spell a difficult financial problem for private ownership.

The data in table 70 indicate that the rating of adaptability of range-type groups to private ownership, which was used in estimating future ownership distribution, is relatively correct.

TABLE 70.—*Present grazing capacity and percentage of depletion of range-type groups*

Range type group	Present area required per animal-month	Average depletion	Relative adaptability to private ownership
	Acres	*Percent*	
Tall grass	5.4	28	1
Short grass			
Pacific bunchgrass	6.9	22	2
Sagebrush grass			
Woodland-chaparral	9.7	51	3
Pinon-juniper			
Sagebrush grass	15.7	37	4
Southern desert shrub			
Salt-desert shrub			

Estimated Shifts in Private Range Lands with High Public Values

Another problem concerns the range lands having key values for such public purposes as watershed protection, game range, and recreation, on which private ownership cannot reimburse itself for the cost of conserving public values.

Under our form of government, workable mechanisms do not exist to reimburse an individual landowner for care or costs incurred to preserve or foster public values. A simple example is winter range for big game. If the herd is to be maintained, feed must deliberately be saved, and this means understocking rather than full or overstocking to domestic animals. The cost lies on the private owner and there is no ready way in which he can reimburse himself for his outlay. Not only that, but he is likely to be regarded as a bad citizen, lacking in public spirit, by groups interested solely in wildlife. He is on the spot, and individually is helpless. His private ownership is beset with difficulties, however he handles his land.

Even more complex is the situation of the owner of range land having high watershed value. Financial pressure for income commensurate with costs may force heavy use, resulting in range depletion, soil deterioration, and unsatisfactory water flow. If he refrains from overstocking, it costs him something. But the beneficiaries are perhaps a thousand miles distant, across two or three States.

These cases typify inherent defects in the institution of private land ownership and raise sharply the question whether some means can be found either to bolster up continuing private ownership or to place such lands in public ownership where the public can pay for the benefits received.

To Restore and Conserve Watershed Values

In another section of the report the watershed situation on range lands is presented. On a large part of the private range-land area watershed values have not been given the consideration which they justify. Misuse and abuse of private range lands at the headwaters of streams in Davis County, Utah, for example, are responsible for the destructive floods in that area. Millions of acres of other private range lands are badly depleted from overgrazing, and some from unwise cultivation, with the result that accelerated run-off and abnormal erosion are causing other destructive floods, endangering life and property and silting irrigation, power and municipal reservoirs. The problem on private lands centers primarily around areas which are eroding to such an extent that they are contributing silt to major streams which furnish the water upon which irrigation, industry, and other community welfare depend. The situation on private lands and the area which it appears should be acquired by the public in each watershed class in order to afford adequate protection is given in table 71.

TABLE 71.—*Watershed situation on private range lands*

Character of land	Total area	Part to be acquired by public
	1,000 acres	1,000 acres
Principal water-yielding areas:		
Contributing little if any silt	45,617	11,000
Contributing an appreciable amount of silt to streams:		
Severely eroded	7,511	7,000
Materially eroded	12,987	10,000
Areas of minor water yield:		
Silting streams:		
Severely eroded	66,185	44,000
Materially eroded	77,052	26,000
Not silting streams:		
Severely eroded	30,828	
Materially eroded	95,514	
Slight or no erosion	42,006	
Total	375,647	118,000

PRINCIPAL WATER-YIELDING AREAS

The principal water-yielding range area, that is, the range part of the watersheds yielding 85 percent of the flow of major streams (183 million acres), is more than one-third in private ownership. It is possible that most of the 46 million acres of this area which is not contributing silt to streams might continue in private hands. Particularly important portions of this area, however, especially those on municipal watersheds or other high-value or high-erosion hazard areas, and especially parts severely eroded, should be brought into public ownership in order permanently to insure use which safeguards public interests. A conservative estimate would be one-fourth or around 11 million acres.

Of the entire principal water-yielding area, 60 million acres is eroding and contributing an appreciable amount of silt to streams. About two-thirds of this area is already in public ownership, or in Indian lands under control of the Federal Government, and requires principally change in use or restorative treatment.

Since the job of restoration of plant cover on key water-producing areas that are eroding is a large one, continued private ownership of any considerable part of the 20.7 million acres of private land so classed is unlikely to result in the doing of things necessary to protect public interest. Public ownership and multiple-purpose management, with the public paying for what it gets, appears to be the answer. Practically all of the 7.8 million acres that are severely eroded and most of the 12.9 million acres materially eroded should be taken into public ownership, or a total of about 17 million acres.

MINOR WATER-YIELDING AREAS

Approximately 174 million acres of private land classed as of minor water-producing importance is contributing an appreciable amount of silt to major streams. Although these lands produce but a small part of the water of the major rivers, they include some of the most critical erosion areas.

Outstanding and spectacular examples of erosion are the Missouri River "breaks" in Montana; and the Badlands of South Dakota.

Both are relatively small in area, but because of highly unstable natural conditions, enhanced by range use, they combine to contribute a large part of the silt in the Missouri River. This silting can be reduced by conservative use.

A very much larger area of private lands throughout the West and especially on the low-water-yield parts of the Colorado, Gila, and Salt Rivers, and the Rio Grande, makes a less spectacular but even more important erosion-control problem, because their present impaired watershed condition is primarily due to range depletion. Thin mantles of vegetation, loose and unstable soil, and a delicate balance of plants to climate, combine to make maintenance of forage and soil a peculiarly difficult problem. The processes of deterioration and depletion start readily and proceed rapidly and to extremes; whereas rebuilding can hardly be accomplished even under moderate grazing. The range types primarily involved—such as sagebrush-grass, southern desert shrub, salt-desert shrub, and piñon-juniper—are those most susceptible to serious damage by overgrazing, as shown by the existing depletion, which averages 66 percent for these types, in contrast to the average of 43 percent for the remaining range types. A high degree of forage depletion connotes an even higher degree of watershed deterioration. Moreover, the susceptible types are in climatic provinces characterized by high summer rainfall intensity, and are thus peculiarly liable to severe erosion from this source. Studies show, too, that the task of restoring forage and watershed values in these types is difficult and will involve high investments in reseeding and erosion-control devices in relation to grazing values. Coupled with this relatively high cost per acre for restoration is the further characteristic of the named types, that their grazing capacity is so low that generally they are submarginal for private ownership.

That public policy should accept the task of restoring such lands seems obvious, since the silt from them finds its way finally into major reservoirs, already developed as long-term public investments.

The size of the watershed problem at present cannot be more than approximated. It involves large areas of public domain, grazing districts, and Indian reservations, as well as State and private lands.

Of the 174 million acres of private land silting streams, 96 million acres are severely eroded. Undoubtedly as a minimum, two-thirds of the latter area should be acquired by the public, possibly 64 million acres. Most of this land is already submarginal for private ownership because of range depletion or naturally low value. Of the remaining 78 million acres of land materially eroded, part of which is submarginal, the acquisition of one-third by the public would appear to be desirable to assure adequate watershed protection.

TOTAL AREA REQUIRING PUBLIC ACQUISITION

The total area of private land contributing silt to major rivers on both major and minor water-producing areas is, as shown in table 71, 195 million acres. Improved management on private lands, as recommended in a later section, if consummated will overcome unsatisfactory watershed conditions on part of this area; still, on a conservative basis it would appear that approximately 107 million acres of this silt contributing area on both principal and minor watersheds should pass out of private ownership. When this area

is added to the 11 million acres of privately owned nonsilting principal water-yielding areas it would make a total of approximately 118 million acres which should be acquired because of watershed value. This area will include a very large part of the 118 million acres for which public acquisition is recommended on account of submarginality.

CRITICAL WATERSHED LANDS REQUIRING NONUSE BY LIVESTOCK

Since overgrazing has been the primary agency which has caused depletion of the cover and hence impaired watershed values and soil wastage, the primary remedy is to be sought in more moderate stocking. This course may be expected to be effective on most of the 352 million acres of land contributing silt to streams, and now more or less seriously eroded. Earlier discussion has made clear that not all depletion and deterioration are equally rapid, severe, and consequential. Some of the broad types of range, such as the short-grass plains, withstand persistent punishment if not too severe. Such a vegetation mantle may continue under heavy use and neither forage, water yield, nor soil be critically disturbed. Damage, if not too far advanced, can be repaired with comparative ease and speed under moderate use. The foothill type of the Central Valley in California likewise has a high resistance against misuse.

On the other hand, as has been previously mentioned, semidesert types on sloping land are especially susceptible to damage. Likewise, the better plant types are susceptible to further severe damage after they have deteriorated so that most of the fertile top soil has been lost. Under such conditions, rehabilitation under grazing use is extremely slow.

As range types differ in susceptibility to punishment, so do different types and areas vary in their public value for watershed protection. Areas on the Colorado River watershed, where erosive processes are already far advanced, are contributing in a major degree to silting of the Boulder Reservoir. Stopping of such soil losses becomes obviously of the first importance. Similar lands back of the Elephant Butte Dam, likewise pouring mud down, have public value many times greater than their slight value for forage. On the contrary, many areas of flat desert clearly have little or no influence on watershed protection.

Thus nonuse is necessary principally in range areas which have high watershed values and are highly susceptible to damage. Such conditions are primarily concerned with (1) critical parts of badly eroding areas which are causing destructive floods, and (2) areas contributing silt to streams where soils are of such unstable character and vegetation depletion has reached such an extreme stage that any use by livestock would impair the effectiveness of the scant cover now available and cause undue disturbance of the soil. In the latter instance, ordinarily found on semidesert range types, the grazing capacity is naturally so low that, with the depletion which has occurred, the land is now practically if not actually submarginal for grazing use by livestock anyway.

Most of the 11.5 million acres now roughly estimated as needing permanent nonuse lies in the Great Basin and Southwest. Since these areas recommended for nonuse, aggregating but 1.6 percent of the total usable range areas, are principally in the types having

lowest forage values, the reduction in grazing capacity for the range country as a whole is even less than the percentage of total area required for nonuse. It is calculated at 0.8 percent of the total cattle-range capacity and 1.17 percent of the total sheep.

As a matter of fact, so unstable and susceptible to damage are some of the range types that, even though no consequential watershed conservation problem existed, there would be a question whether they should be used for domestic livestock. Establishing a business on such an unsure and vulnerable basis is hardly to be regarded as desirable, either for the individual or the community.

The removal from range use of the 11.5 million acres will for all practical purposes not affect the industry or the economy of the range country.

TO PROTECT WILDLIFE

In many places winter range for big game is the indispensable key to maintaining specific game herds. On the vast majority of the range area, moderate stocking to domestic animals, within the true grazing capacity of the range, will leave room for wild animals, and no blanket removal of livestock is necessary or desirable.

A part of the problem is to remove from range use key areas urgently needed for recreation or game, where the pressure of these inescapable demands is so severe as to make any combination with domestic livestock and other uses impracticable. Where there is heavy camping or other recreational use, for example, or where there is a heavy concentration of hunters, even for a short period, the range livestock business inevitably suffers. Moreover, stock interferes with human use and occupancy, and the unavoidable tension and conflict must on such key areas be resolved by excluding domestic stock. Considerable parts of the high Sierra in California, for example, have for years been without domestic stock for this reason.

Removal of such lands from domestic livestock use in particular localities has been and is inevitable, as competing and inescapable public demands of growing population and growing outdoor recreation develop. For example, 4,240,000 acres of usable range on the national forests have been closed for exclusive use for wildlife and recreation. Some additional areas may need to be closed from time to time as specific problems develop. Other areas, as conditions on adjoining ranges change, may no longer be required for exclusive use and may be opened for multiple use. The areas so affected form a relatively small part of the whole range area, but are critically important where they do exist. Most acute at the present time is the need for shifting from heavy use by domestic livestock which in turn practically excludes use by wildlife, to multiple use on certain areas needed to supplement existing multiple use range. Especially important is the need for additional winter range to supplement the present summer game range on the national forests in many places in the West. This involves both public domain and privately owned lands. Where privately owned range is involved public acquisition usually is necessary. In table 72 are given the best available estimates, both for private and for Federal lands, of the additional area needed to support specific population of game along with lighter use by livestock. The estimates for game, both for public and private land, are by the Forest Service; those for waterfowl areas are by the Biological Survey.

TABLE 72.—*Areas needed for use of wildlife*[1]

[In thousands of acres; 000 omitted]

State	Public domain	Private land outside national forests	Private land inside national forests	For waterfowl	Total area
Arizona	944				944
California	1,219	381	67	11	1,681
Colorado	4,441	2,734	327	7	8,119
Idaho	816	302	80	78	1,276
Montana	69	282	210	40	600
Nevada	1,868	13	21	24	1,926
New Mexico	886		206	37	948
Oregon	1,272			130	1,402
Utah	1,732	471	61	124	2,379
Washington	138			80	218
Wyoming	515	294	34	19	792
Nebraska				74	74
North Dakota				125	125
South Dakota	11	165	71	14	261
Texas				6	6
Total	14,102	4,442	1,227	948	20,510

[1] No estimates are available for Kansas and Oklahoma.

TO ROUND OUT NATIONAL FORESTS AND GRAZING DISTRICTS

Within the national forests are approximately 10.5 million acres of alienated range lands mostly in scattered relatively small isolated tracts. In other places national-forest boundaries are so located as to divide natural topographic livestock or game range units. Both situations tend to render difficult the application of range management and the conservation of wildlife. It is estimated that approximately 8.9 million acres inside and 10 million acres of privately owned range land adjacent to national-forest boundaries should be acquired by the Federal Government, of which practically 8.2 million acres is in the open forest type and is not accounted for in table 68. Much of it is submarginal for private ownership. Practically all of it is of high public value for watershed protection or wildlife production or both and overlaps with land recommended elsewhere for acquisition for those purposes.

The area needed to consolidate grazing districts on the public domain is not known, but may be large. The program recommended later will, if carried out, greatly improve the chance for most effective management of the districts.

THE NET AREA TO BE ACQUIRED

Public acquisition of range lands now in private ownership has been found to fulfill five broad purposes. These are:

1. To retire from crop use and restore to range use low-productivity lands requiring a long period and a cash outlay to restore range values.
2. To manage constructively and restore productivity on lower-grade range land, which private ownership tends to exploit and deplete.
3. To place under conservative management critical deteriorating watershed areas.
4. To make available for use by wildlife key tracts of range required for specific wildlife populations.

5. To round out natural range units on and adjacent to the national forests and to afford them more effective administration for public purposes.

The estimates of total acreage for each of these purposes and classes are restated as follows:

	Acres
Areas to retire from crop use	15,000,000
Range areas submarginal for private ownership	113,307,000
Range areas for protection of critical watershed land	118,000,000
Range areas for use of wildlife	6,813,000
Range areas to round out natural units in national forests (including open-forest type)	18,000,000

If it is assumed that the area in each class coincides not at all with that in other classes, then obviously the total indicated acquisition program is the sum of the five class totals. By definition this is true of the two first items. It is also true of the 8.2 million acres of open-forest type not accounted for in table 68, which is also included in the fifth class total above. The indicated program for these three classes is, therefore, 136.5 million acres.

As to the other two classes of range land, however, the degree of overlapping is not so readily determined. The detailed calculations, not repeated here, show that, State by State, the total of retired cropland, of submarginal range lands and of proposed national-forest acquisitions in the open-forest type practically equals or exceeds the estimated area for protection of major watershed areas and for wildlife range. Without far more extensive field data than are now available, it is impossible to assert whether, acre by acre, the smaller will be included in the greater, although in the main probably they will.

Watershed lands in general would probably be included in the program already suggested, since on the whole they lie in the types most susceptible to mistreatment, and least adapted to private ownership. Doubtless, some areas will need to be acquired for watershed protection alone, but probably these will not be great in comparison to the entire suggested program.

Range lands acquired for watershed protection, because of submarginality, or for wildlife, should also go far in meeting some pressing problems of consolidation. Both on and adjoining the national forests and grazing districts, as already pointed out, are areas of private land, public ownership of which is required to fully realize plans for range management and restoration.

So, with present very approximate knowledge, and with a very large program of public range land acquisition indicated as desirable, a minimum of 125 million acres appears to be a conservative initial program. Critical needs for public ownership of submarginal range and crop lands, for watershed and wildlife protection, and for effective Federal range land administration will doubtless be reasonably well met by such a program.

CHANGE IN USABLE RANGE AREA

The net effect then of these probable changes in form of use is to increase both the area and the grazing capacity of range lands in the range country.

The decrease in range for domestic livestock by closing to grazing the critical watershed area of 11½ million acres is far less in area

than the increase in range by the gradual acquisition of the 15 million acres of privately owned submarginal croplands. The grazing capacity of the latter (3,750,000 animal months) will be so far in excess of that of the area to be closed (1,085,000 animal months) that ample range will be available for any domestic stock temporarily removed from limited areas, or whose present numbers may be slightly reduced, to provide adequate range for wildlife.

Problems of Public Ownership

The problem of unreserved Federal range lands

For range lands on the national forests and for Indian range land a stable policy has been established. A similar set-up is in process of being worked out for 80 million acres under the Grazing Act. But some 82 million acres of public domain beyond the amount already authorized will still be unreserved and entirely unmanaged. Not only that but the old public-land laws still operate to pass into private ownership lands even inferior to millions of acres already patented and now a major problem in the whole range question.

Permanent reservation of all Federal range lands and revocation of land-disposal laws which afford an invitation to trouble are obvious and immediate needs—as other sections of this report show.

The problem of State-owned range lands

All sorts of situations are found in the several range States. Scattered square miles of land, impossible to administer, in some; fairly solid blocks of land in some; and intermediate conditions in others. The nearest approach to a common denominator is in the general policy, largely based on Federal grant laws, to pass State lands to private ownership, to handle them from the real-estate standpoint, as a source of immediate revenue, rather than from the land-management or conservation standpoint as a permanent asset.

On the whole, then, State range land policy has had the same essential defects as the Federal attitude toward the public domain. The results have been similar—a drift of low-grade lands into unstable and shifting private ownership—changing one problem for another with no real progress toward solution.

The problem of tax-reverted lands

Records of the location and area of lands which have gone through the process of tax reversion are incomplete and fragmentary. That millions of acres have for all practical purposes been abandoned by private ownership, through persistent tax-delinquency, even though the counties or the States have not asserted title, is well known. Naturally, during a continued depression many properties are tax-delinquent for several years, through inability to pay taxes rather than through lack of intent. The fragmentary available figures thus fail to afford a true picture, even for the scattered areas covered, of the extent of deliberate tax reversion.

It is not always fully appreciated that owners who have thus abandoned lands have in most cases already gone through all the

devices and struggles which ingenuity can devise. To repass such lands to other private owners, even at reduced valuations—and this is the common practice and purpose of local government—generally means a repetition of the losing struggle, with only a different owner. In many if not most cases the very process of abandonment not only furnishes a final and convincing decision as to submarginality of the lands for private ownership but, by inference, gives an answer as to their future disposition. Clearly, low-grade range lands that are in fact abandoned should pass to local public ownership as a first step in recognition of the fact that they are unsuited for private ownership. The general hesitancy and delay in formal seizure of title has been due to failure to accept the fact that such lands are better off in public ownership. A change in this viewpoint adequately expressed in State laws and in local administrative action is urgently needed.

But, because in this process the county loses in tax base and acquires a property requiring cash outlay to restore, it is highly improbable that many counties will be financially able to retain any ownership that involves constructive management. A second phase is then the passing of title to the State on an equitable basis of recompense to the county government by the State. Whether the State in turn consolidates, retains, and manages such lands or passes them to Federal ownership is not the main question. It is rather a more ready acceptance of title by the public to lands clearly unsuited for private ownership on a nonexploitation basis of use.

DIVISION OF RESPONSIBILITY BETWEEN STATES AND FEDERAL GOVERNMENT IN RANGE-LAND OWNERSHIP

Of the 125 million acres which are estimated as the minimum area to be acquired and managed by public agencies, much the greater part, certainly not less than 90 percent, is low-grade land. The prime reason for its acquisition is to restore productivity and manage conservatively—the very things which private ownership cannot do.

The implication of the very method of estimating the area to be acquired is that the lands will not yield a large net income, if any. The justification for public ownership will be the restoration and preservation of basic wealth and opportunities for private enterprise and for support of population, and in addition the protection of public values in watershed and wildlife. A part, and probably a large part, of the income to governmental treasuries will come indirectly, chiefly through operation of the income-tax laws.

Since the true grazing capacity, and therefore true rental value, of such lands is low, since they are depleted to varying degrees, and since they will require varying periods of nonstocking or light stocking to restore productivity, it follows that as an investment they are unattractive.

Federal laws have colored the attitude of the Western States toward their State-owned range lands so that the dominant purpose has been to obtain the maximum immediate cash return, and to worry little about restoring or even maintaining productivity. No State, for example, has created a professional range-management

service, or has utilized fully the technical knowledge and ability of its Agricultural College staff in handling its range lands. Rather, the lands have been entrusted to State agencies dominated by the immediate financial viewpoint.

But leaving aside the indications of past State action, where public values of an interstate character, such as watershed protection, are involved, it is difficult for a State to express its interest through restraint in managing its lands. Many millions of acres destined for public acquisition are vested with such public value. They naturally will be managed by the Federal Government, because of the interstate values on most of the range lands, and because the major return will be obtained indirectly through maintenance of basic wealth, rather than directly in cash income from the properties.

Moreover, it is inevitable that the bulk of the acquired lands will require cash outlays for rehabilitation, probably for some time in excess of income, particularly since a large area is abandoned dry-farmed land, requiring substantial cash outlay for rehabilitation. Not many of the Western States can reasonably be expected to make such outlays on a large scale, since the burden of carrying existing State obligations is too great to permit branching out into new ventures to any high degree.

The other side of the picture is that the States are already in the range-land business, because of holdings of land grants and properties acquired through foreclosure. If, as suggested in the section on legislation, tax-reverted lands are vested in the States, the State ownership of range lands will increase further. It is unquestionably desirable that the States as partners should share with the Federal Government the very large job of public ownership and management of range lands.

Just as in appraising the opportunities for successful private ownership and management in the less favorable range types, it was assumed that a certain part of the total in each type was sufficiently superior to justify private ownership, so, even though range lands in public ownership are on the whole unattractive as a money-making investment, some part of the whole should prove superior to the general level.

As an operating principle in working out the sphere of influence in the suggested acquisition program of the several States and of the Federal Government, it is desirable to leave to the States the most favorable part, with the Federal Government taking over what neither the private owner nor the States can handle.

Since this report represents the first attempt to appraise the size of the public ownership job—an appraisal that may well be markedly low, and one requiring much more study and testing—it would be altogether premature to attempt a fine-spun division of the job between State and Federal Governments. There is abundant room for both agencies.

The Process of Solution of Ownership and Use Problems

A group of overlapping and interwoven ownership-and-use problems clearly lie close to the core of the problem of restoring and stabilizing the range. It is equally evident that no single method

and no single class of owner can unaided expect to solve difficulties which have developed from past action and inaction by all. The solutions will come from many modes of action, both private and public. In such a partnership venture, a great deal of joint study, a great deal of good sense, and a genuinely cooperative approach are requisite.

A broad and accepted division of responsibility which would leave first to private owners, second to the States, what each can do, and lastly to the Federal Government what remains, is an obvious and realistic approach to the whole problem.

The Federal Government has already recognized the existence of range-land ownership problems and developed several modes of action which can help effectively in their solution. Therefore no major departures in the theory of government need to be considered. Among means of action, acquisition stands out, not as an exclusive or theoretically superior method but rather as one that strikes directly at problems of private lands with high public values, and of lands submarginal for private ownership.

Clearly the first need in a progressive attack is to initiate a range-land acquisition program of the order of magnitude apparently required. Whether the true size of the task is higher or lower than estimated should not obscure the fact that it is a very large and urgent task. In any event, many years will be required to carry out such a large task and one needing such large capital investments for purchase and rehabilitation of the land. More exact estimates, and far more exploration of the fields for action by different agencies of government, are clearly needed, but this fact should not halt a prompt start. Nor should the obvious but undetermined relationship between land-use adjustments in the range country and in the central agricultural regions be a deterrent to prompt action. Such questions can be cooperatively studied and worked out as the acquisition program develops.

For over and above the factual questions for which final answers are not available stand the clearly established facts that the range is the permanent key to western agriculture and western economy; that it has been seriously depleted through overuse and reduced by uneconomic private ownership; that its problems can be solved only through aggressive public action; and that further delay is intolerable.

That this first attempt to approximate the size of the public range-land ownership job results in an answer of large size means simply that the job is a large one. The number of acres acquired in different types and States will probably vary considerably from the estimates. The process of working out acquisition programs, once they are established, takes care of such problems. Public agencies establish bases of valuation which are strongly conservative—since if questions of wasting public money arise, the program will surely cease. Private owners, with often more money tied up in land than is offered by the public, will not sell unless convinced that the losses thus accepted will be more than offset by gains in business efficiency and financial flexibility. So the size and location of public acquisition is quickly determined, not by studies or laws, but by private ownership itself. The need is to start acquisition on a programmed scale commensurate with the job ahead.

THE ADMINISTRATION OF PUBLIC RANGE LANDS

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There are two broad classes of range land in the western United States the ownership and management of which are a public function. In the first class, typified by the national forests, are lands representing special values of high public interest, such as timber growing and mountain headwaters of important streams. Included in this class are related intermingled areas, usable chiefly for grazing, wildlife, and recreation or, because of location and topographic unity, inseparable for the purposes of administration. All of these intermingled lands in Federal ownership are recognized by law and usage as being of national-forest character.

In the second class are the range lands of little or no utility for forest growth and of minor importance as a source of stream flow, often with forage values so low or so impaired as to be submarginal for private ownership, requiring protection against erosion and floods, and demanding conservation of the grazing, wildlife, recreational, and other resources. Broadly speaking, this class includes the semiarid or arid plains, the plateaus and minor interspersed mountains and valleys, and the low quality dry-farm lands. Federally owned lands in this category are recognized as being of a character suitable for administration as grazing districts.

In addition, several States, numerous counties, and some of the municipalities in the West own more or less range land of the two classes mentioned above. The Federal Government as guardian of the Indians also has primary responsibility for the management of Indian range lands. The acreage and present condition of the Federal, Indian, State, and other publicly owned range lands are shown in table 73.

TABLE 73.—*The present acreage and grazing capacity of public and Indian range lands in the Western States*

Ownership and form of management	Gross area	Available public range	Degree of depletion of virgin grazing capacity	Estimated present grazing capacity
	Acres	*Acres*	*Percent*	*Acres per animal month*
Grazing district lands:				
Grazing districts	85,123,430	76,927,200	67	
Unreserved public domain	99,995,710	97,224,205		
Other	20,173,344	21,366,675	62	
Total	205,292,225	195,518,430		12.05
National forest	152,574,975	82,682,149	80	7.22
Total Federal	335,241,497	278,200,587		
State	43,307,680	38,225,527		
County and municipal	6,675,660	6,990,575		
Total	73,973,840	45,223,102	40	5.60
Total public range	360,114,130	327,413,689		
Indian lands	51,043,004	46,960,979	51	8.17
Total for public management	422,156,140	345,423,448		

It is estimated that there is approximately 125 million acres of primarily low quality alienated range and crop land, including abandoned dry farms, which, as pointed out previously, is undoubtedly destined for some form of public ownership. A considerable share of this land may automatically revert to State or county on account of tax delinquency; a smaller part consists of lands, title to which will revert to State ownership on account of foreclosure on loans made from State trust funds; and a third portion should be acquired by outright public purchase or gift. Whether or not the 125 million acres is the correct estimate of such lands, and regardless of the form of public ownership in which it will ultimately rest, it seems quite evident that the acreages shown in table 73 will eventually be increased by a considerable amount and the task of public-range management will be increased accordingly.

Practically all of the public lands except the national forests and Indian lands have been administered with far too little regard for the perpetuation of yield of resources. This viewpoint still governs in the case of most State lands and only recently has it been modified with respect to a part of the open public domain. It is becoming more and more evident that it is time to undertake a program of management of all public land if it is to be made to contribute a fair share to the support of society.

National Forests and Grazing-District Lands[45]

The administration of the federally owned range lands should be of a character that will restore and maintain the range forage and other values, protect the soil, promote favorable conditions of stream flow, afford the highest sustained yield of all resources consistent with the broader purposes for which the lands are held in public ownership, and best integrate the use of the resources with the use of other lands in the development of a sound agricultural program for the Western States. Such an administration involves:

(1) Correlation in use of public lands to obtain the highest net benefits from all the resources combined.

(2) Skillful management to properly protect, develop, and utilize these resources.

(3) Integration of the public-range resources with related crop and other private and public-range land to secure the highest use from all of the land.

(4) Affording the maximum opportunity practicable to home builders who are entitled to use the range.

(5) Readjustment of land ownerships and use where needed to facilitate economical and efficient management and administration of public-range lands.

(6) A system of administration designed to deal with local problems in accordance with local conditions insofar as is consistent with the protection of the public interest.

Policies have long since been adopted and an administrative organization established in the Department of Agriculture to implement these aims and objectives on the national forests under the

[45] The term "grazing-district lands" is here used to include the group shown in table 73, made up of existing grazing districts, unreserved public domain, and grazing lands in those minor reservations classed as "other Federal."

broad authority conferred by the act of June 4, 1897. Administration has been a going concern for 30 years and during that time depletion has been checked and the range has improved an average of about 19 percent. The resources have been made available for public use in an orderly manner. The chief task of the future is to continue the present program with such adjustments as are necessary to solve existing problems and meet the demands of a sound agricultural economy.

The grazing districts are administered subject to the act of June 28, 1934. This act confers broad authority on the Secretary of the Interior but endeavors to write into law specifications for administration. Many of these specifications are in accordance with the aims and objectives sought, but, as pointed out earlier in this report (pp. 286–294), certain provisions were written into the act which may offset many of its favorable features. Among its outstanding defects is the limitation of management to 80 million acres, instead of including the whole 149.4 million acres of usable range suitable for administration as shown in table 73.

The problems confronting a real and effective administration and management of the grazing districts are formidable. The productivity of much of the land is normally low because of adverse climatic conditions. Long neglected, these federally owned range lands are now in bad shape. Grazing capacity on the usable area has been depleted to less than 35 percent of virgin condition. Depletion has brought excessive run-off and water or wind erosion of serious proportions almost everywhere. Wildlife resources have been greatly diminished. Communities have suffered because of the uneconomic use of the land.

The solution of these problems exhibits two major phases. The first is a definite and positive plan for restoration and wise use of the plant cover for watershed and soil protection and the production of forage for domestic livestock and game; and second, the integration of these lands and their resources with related agricultural lands of the West.

MULTIPLE USE OF RESOURCES

The soundness of the policy of devoting all the land "to its most productive use for the permanent good of the whole people" and not for the exclusive benefit of special groups or industries, as pointed out earlier, has been proved on the national forests. While grazing of domestic livestock is recognized as a major use of range land it is important that other resources be given adequate consideration.

The high degree of correlation necessary to obtain effective conservation and use of the associated resources on the land emphasizes the need for territorial rather than functional jurisdiction in administration of range land. The expert services of other agencies should be used as needed, but in order to accomplish the necessary correlation and to keep down the cost of administration, a single agency must retain responsibility on a given body of land. Division of responsibility according to function on the same land leads to confusion and unnecessary duplication of expenditures.

THE NATIONAL FORESTS

The multiple-use principle—including timber production, watershed protection, grazing, wildlife propagation, recreation, and other uses—has been adopted on the national forests and with regard to grazing and water power, which are not mentioned specifically in the organic legislation, has been sustained by the highest court.

Adjustments have been made from time to time on the national forests to meet the requirements of multiple use, and more will be required in the future. One of the essentials in achieving highest use of the land is to maintain sufficient flexibility to meet justifiable new demands as they arise.

Extensive areas exist where the land could well support more game, and there are others where, owing to the operation of State laws, there is overpopulation of game at the present time. These adjustments on the whole will not involve any net reductions in livestock use for the total range area but may be provided for by increased forage production, provided adequate range management is applied.

Watershed protection, timber production, and recreational needs on the national forests, on the whole, also may be met largely by local adjustments and improvement in grazing capacity. Commercial timber production plays a part on about 43 million acres of national-forest ranges, and an additional 22 million acres of other forest-range areas have important cordwood, fence post, watershed protection, and other values. Nearly 94 percent of the national-forest range is of importance in watershed protection. This involves 79 million acres of high water yield. Material or severe erosion is still occurring on 20.4 million acres which is contributing silt to major streams. It is estimated in the light of present information that approximately 336,000 acres of this critical area may need to be permanently closed to grazing for watershed protection. This is, however, only about 0.4 percent of the present usable range area on the national forests or 0.5 percent of the present grazing capacity.

GRAZING-DISTRICT LANDS

The grazing-district lands, besides producing forage for livestock grazing, have other values including watersheds, some timber, woodlands, game, and special outdoor recreation. As in the case of the national forests, it will be possible to realize on these values by proper correlation of use and the application of sound range management, although certain critical areas will require special consideration. The Grazing Act, however, is so colored by specific recognition of use by domestic livestock that unless the Act is amended specifically to provide for multiple use this feature of administration may be neglected.

On approximately 22 million acres forest growth must be considered. Still larger areas are important for wildlife, especially winter range.

The main sources of stream flow, because of higher precipitation and accumulation of snow during the winter, are largely within the national forests. However, the lower, more arid grazing-district

lands, which have not been protected, are the source of frequent disastrous floods and excessive silt, which enter the streams after they leave the national forests.

Range rehabilitation will provide much of the necessary protection on the 98 percent of the watershed area that is eroding more or less seriously. There are conditions, however, where lighter grazing than the range alone may require will be necessary. Of the total critical area, of which 74.5 million acres is eroding severely, it is estimated that 4,838,000 acres should be closed to grazing for watershed protection. The total closures amount to about 2.0 percent of the total range area.

The policy in allotting privileges to graze the range should be kept sufficiently flexible to permit adjustments as new needs arise for watershed protection, game production, or other use.

In addition to what may be accomplished by regulated use or closure, special erosion-control work is needed on a large area of the grazing-district lands. It is difficult if not impossible at this stage to estimate the acreage that might successfully be treated. Methods and practices are being developed by research and sufficient progress has been made to indicate that such work has a place in the range program, but until these studies have determined the practical and economical limits of application, it is not possible to make a reliable estimate of what the program should be.

RANGE MANAGEMENT

Range management, as here used, has to do with determining the proper grazing capacity, season of use, class of livestock, grazing systems to revegetate and maintain the range, handling of livestock on the range, the location and construction of improvements to facilitate best use of range, reseeding, game management, and all related activities necessary to attain the highest use consistent with the protection and sustained yield of all the resources. In short, it is a job of applied biology.

Conservation and protection of the resources may be achieved with little skill or efficiency merely by restricting use. To do so, however, would deny a dependent population of the use of the resources otherwise available to them. The more efficient method is to apply the knowledge and skill which will result in the highest yield of resources consistent with their perpetuation. This should be the aim in the management of public range.

THE NATIONAL FORESTS

The major steps in range management in the national forests, including adjustments in numbers of livestock and seasons of use to permit rehabilitation and perpetuation of the forage resources, have been completed. Grazing capacity, however, is not static. As range conditions improve, increased use may be possible in some places or further restrictions may be necessary in others on account of new demands for other uses, or to correct local overgrazing. The present stocking of the range is 12.2 million animal months or at the rate of 6.76 acres for each animal month. At the moment adjustments are needed on local areas aggregating approximately 20 percent of

the used range area on the national forests to repair damage incurred by the recent drought and postponed reduction of livestock during the depression. The present grazing capacity is at the rate of 7.2 acres per animal month. The aggregate reduction needed amounts to approximately 795,000 animal months or 6.5 percent of the present total grazing use by domestic livestock. Seasonal use should be corrected on the 12 percent of the range not now in proper adjustment. These immediate adjustments should be completed within the next 5 years.

It is estimated that, when restored to such productive capacity as as may be developed within the next 50 years, the national-forest ranges may be expected to become capable of supporting livestock at the rate of 6 acres per animal month or 18.7 million animal months per annum—an increase of approximately 20 percent over the present grazing capacity. Most of the restoration can probably be completed within the next 15 to 20 years. Of the eventual increase in grazing capacity, however, a part will be shared by additional wildlife and the equivalent of 55,000 animal months will be subtracted for areas closed to domestic livestock for watershed protection. These estimates assume that there will be intensive range management. Achievement will fall short of this goal to the extent that range management falls short of the possibilities now known.

The accomplishment of range management, in addition to more research as set forth in another section of this report, will require the completion of a range survey, of management plans, and of range improvements, artificial reseeding, and additional administrative personnel, the amounts and costs of which are set forth in a later part of this section.

GRAZING-DISTRICT LANDS

On the grazing-district lands, in view of the larger area, the long years of neglect, and the bare beginning of administration, the range-management task and additional expenditures needed are much larger than for the national forests. Forage production has been reduced to less than 35 percent of the original capacity. It is estimated, based on best available information, that at the present time these lands are furnishing an inadequate forage supply for 21.9 million animal months of livestock annually, at the rate of 6.83 acres per animal month. The present capacity of the usable range area, if stocked on a basis to stop further depletion, provide watershed protection, and insure gradual rehabilitation, is estimated to be at the rate of 12 acres per animal month or approximately 12.4 million animal months per annum. This represents a reduction of 43 percent from present use. The capacity of the range to support this reduced number of livestock depends upon how nearly management is applied to the full extent of its possibilities. If management is not fully applied, and the broader public interest is to be protected, an additional reduction of range use will be required, of anywhere from 10 to 40 percent, depending upon the intensity of management.

The heavily damaged ranges, because of severe soil depletion and the extremely slow natural process of rebuilding, may not be restored to full capacity within the next two generations, even under the best management. It is estimated that the productive capacity of the

present range area as a whole should be restored sufficiently within 50 years to support adequately the equivalent of the present number of livestock, or at the rate of 6.8 acres per animal month. A portion of this increased capacity, however, will be required for game and for areas closed to grazing for watershed protection.

Other steps in range management in addition to reduction of the number of livestock to the present grazing capacity are necessary on each individual range unit. Systems of grazing to promote natural revegetation must be applied. Areas which cannot be made to revegetate naturally should be reseeded artificially. Improper seasonal use should be corrected. Critical watershed areas should be located and given special attention or be closed to grazing. Needs of wildlife must be critically analyzed and provided for. Rodents should be controlled where damage is excessive. Necessary research should be undertaken. Watering places and other essential improvements must be planned and constructed to facilitate use of the forage and the application of range management.

Obviously action to accomplish the adjustments in range use necessary properly to restore the range and use the land should not be too sudden or too drastic. The whole program should be worked out by a gradual and orderly process to avoid unnecessaray sacrifice of present investments of dependent enterprises. The important thing is that a policy be adopted and a plan of action initiated which in due time will reach the desired objective. This necessitates a well planned, closely knit, aggressive, administration.

Because of the wide variation in conditions of topography, soil, slope, vegetation, rainfall, and dependent watershed values, even within relatively small areas, and in adjustments needed in land use, blanket rules and plans in management will not suffice. A separate prescription, in the form of a management plan based on the local situation must be prepared for each range of watershed unit. The first step after the initial temporary broad adjustments are made, therefore, should be an inventory of resources and conditions to establish an adequate factual basis. This should be followed by the preparation and application of definite range-management plans for handling each unit of range and thorough periodic inspection to assure accomplishments.

The investment necessary for management plans, development, and improvement of the range is discussed under a later heading.

INTEGRATION OF PUBLIC RANGE LANDS WITH AGRICULTURE

The development of a sound agricultural program for the West requires the integration of the national-forest and grazing-district lands with the related agricultural resources in a manner to promote the social and economic welfare of the dependent population. In many parts of the West the summer range on the national forests, the spring-fall and winter range on the grazing districts, privately owned range lands, and crop lands (especially that best suited to forage production), are complementary parts of a single agricultural structure. The aim in the administration of the public range should be to give preference to the farmer or livestock grower who needs public range to supplement his crop and range land. Another aim should be to encourage the building up and maintenance of economic

units—that is, home units capable of supporting a family on a reasonable standard of living—as against concentration of the use of the public range in the hands of a few.

Application of these principles has met with a fair degree of success in the administration of the national forests but several factors have hindered a more extensive development of home units. One of these has been the laissez-faire policy in land occupation and use, including the unregulated use of the open public domain, which has placed the small farm operator at a disadvantage in acquiring the necessaray outside farm or range land with which to supplement national-forest range. A second factor has been the submarginal nature of a portion of the ranch units outside the national forests. Still another, in part growing out of the other two, has been the unstable nature of the occupancy and use of agricultural land in and adjacent to the national forests. Now that maladjustments in land ownership and use are beginning to receive attention and at least part of the public domain is to be regulated as grazing districts, it will be possible, especially since so much of the range land is still in public ownership, to begin to correct a bad situation. In such a program the public and privately owned range and forage croplands should be considered in full relationship to each other.

Certain adjustments can and should be made on the national forests and grazing districts on the basis of present knowledge and information. But the situation is too complicated to proceed on a cut-and-fit basis. What is needed is a reconsideration of the whole basic structure. The first step to such an approach is a comprehensive resource and economic survey to assemble the basic facts as to total resources available on all classes of land, to ascertain present condition, adaptability to different uses, interdependability of use, suitability to different kinds of ownership, quantity of range, and other agricultural land required for a minimum economic home unit and ultimate best ownership and use. Upon such a basis may then be built a program of land use and ownership adjustments which will aim in the end to attain the highest use of all the agricultural resources for the satisfactory support of homes and people. Administrative policies for public lands should be modified to fit into the whole pattern. Such a program will require a long period of adjustment, but the aim should be to develop the plan and set in motion the forces which will lead in the direction desired through regular economic processes.

Such a plan should not automatically contemplate the dissolution of the larger outfits. There are conditions where, in order to be economically successful, large capital investment and large scale operations are necessary and can best be handled as individual or cooperative enterprises. Such an economy, however, in order to be socially sound, must comprehend equal or greater stability in satisfactory maintenance of dependent populations than smaller-sized units, and must be equally efficient in the use of the resources.

Accomplishment of the objective of integrating the forage resources of a grazing district with dependent agricultural resources, as discussed in the preceding chapter, will require certain modifications and clarification in the Grazing Act. One clause which should be repealed gives owners who carry loans on their livestock prefer-

ence over others in the issuance of permits. This, in effect, promotes monopoly of the range regardless of how such perpetuation may adversely affect the interest of others. Another clause which should be clarified may be interpreted to give preference to existing property rights rather than to human needs in the distribution of public benefits. Certain other clauses are ambiguous and might be construed to grant to favorably situated stockmen indefeasible rights and privileges, either directly or indirectly, by making the Federal law subservient to State law.

GRAZING FEES AND PAYMENT TO THE STATES

The forage resources on public lands have a value for which the user should pay a fair fee. The method of range appraisals employed on the national forests is to relate the fee paid on public lands to the cost of owned or leased range in the locality, with offsets for disadvantages inherent in the public range. This appears to be fair and equitable and suitable to application on all public range lands.

At the present time 25 percent of the gross revenue collected for grazing livestock on national-forest ranges is paid to the States for distribution to the counties in which it was collected, to be used for road and school purposes. The Grazing Act provides that 50 percent of the revenue collected on grazing districts shall be repaid to the States. There appears to be no sound basis for this inconsistency.

These repayments are made to offset in a measure the income the States and local subdivisions might have collected through taxation had the land passed into private ownership. No attempt is made here to establish an equitable basis for the division of revenue from public range lands. To do so would require a study which is beyond the scope of this report; however, it does seem advisable to mention some of the related facts.

It is true that the local political subdivisions are deprived of some direct taxes when the land is kept out of private ownership and administered by the Federal Government. On the other hand, there are several and perhaps greater indirect benefits. It has been shown (*154, pp. 1095 1124*), for example, in connection with the national forests, that Federal ownership and management of these lands result in numerous benefits to the States, including (1) stability and permanency of local industries dependent upon the land; (2) the protection of watersheds, conservation of wildlife, and development of recreational resources; (3) substantial reduction in the outlay of States and counties for protection and development of the natural resources, for construction of roads and trails, and for the enforcement of State laws and county ordinances. In general Federal ownership and management is thus a form of Federal aid to the States. It is not wholly consistent, therefore, that States should share in an excessive degree in the direct revenue, at least during the period that the Federal Government is making large capital investments for improvements to make the land more fully productive.

INTERMINGLED LANDS AND ISOLATED TRACTS

Among the problems which seriously complicate the administration of public range is that of isolated tracts of alienated range lands interspersed in the larger bodies of Federal land.

NATIONAL FORESTS

Within the exterior boundaries of the national forests are approximately 10.5 million acres of intermingled lands, not less than 75 percent of which should be acquired through purchase or exchange.

Although there is authority for the exchange of public land for private land within the national-forest boundaries at the present time, this provision does not satisfactorily meet the situation. Exchange of lands will assist in some degree by making it possible to acquire strategic tracts of private land. In many instances however, it will only "rob Peter to pay Paul" because management and protection will merely be transferred from one area to another. Most of these lands will probably have to be acquired by the Government by purchase. Legislation is necessary to authorize this procedure.

GRAZING-DISTRICT LANDS

On grazing-district lands also administration is handicapped by a very large acreage of intermingled alienated land. The State-owned lands in this category either should be blocked up through exchange and administered by the State either directly or in cooperation with the Federal Government; or, if left as intermingled lands, management should be waived to the Federal Government and the proceeds, after deducting a reasonable amount for cost of administration, returned to the respective States.

Blocking up of privately owned lands through exchange, as provided for in the Grazing Act, will help to simplify administration but does not entirely solve the problem. Much of the intermingled, submarginal, privately owned lands should eventually be returned to public ownership if management for perpetuation of the resource is to result. Where the Government is an important owner, and pending the adoption of an acquisition program, private owners should be encouraged to waive management to the Federal Government and in exchange be entitled to graze livestock equivalent to the grazing capacity of the waived lands or to receive the fees collected by the Government from other users less a reasonable deduction for cost of administration.

A special ownership situation is found on ranges where water is normally scarce and most of the water holes are now controlled by isolated tracts in private ownership. Unless the isolated tracts are acquired by the Federal Government, management and administration of the grazing districts will be seriously interfered with, especially in view of the terms of the Grazing Act providing that owners of watering places shall be given preference in the use of the adjoining range to an extent necessary to use properly such owned or leased water. This clause may become an instrument for giving rights and

monopoly in the use of public range and thereby defeat the proper correlation of public range with other types of agricultural land. Public interest in public ranges requires that the Government own and control both the land and the water. The private equity in many of these watering places should be extinguished by Government purchase and the clause of the Grazing Act which grants adjunctive right of use to the owner or lessor of water should be repealed.

Another problem is presented by the isolated tracts of public land, of a few to several thousand acres in area, widely scattered throughout many of the more solid blocks of privately owned range land in the West, which cannot readily be administered as parts of grazing districts. The Grazing Act provides that such tracts not exceeding 760 acres may be sold at public auction. Legal subdivisions of public land not exceeding 160 acres unsuited to cultivation, may also be sold to owners of adjoining land whether or not such tract is isolated. The act also provides for the leasing of isolated tracts, if 640 acres or more in area, to owners of contiguous lands.

Federal lands within areas more or less of which will be acquired by the public should, of course, be retained in public ownership permanently. It would be unfortunate therefore, to dispose of any isolated tracts until it is known definitely what areas eventually will revert to the Federal Government or the States.

In range units where there is a moderate quantity of more or less isolated Federal land, say 15 to 40 percent, and conditions are favorable for private ownership of a large share of the range land, as in the Pumpkin Creek–Mizpah grazing district in Montana, discussed earlier in this report, the cooperative-association form of management may be successful. The management of the Federal Government on its land in such cases should prove an effective guide to obtaining good management on the privately owned land as well.

Where both the privately owned and public land is submarginal for private ownership another plan should be followed. West of the Great Plains region, for example, probably 58 per cent of the 167 million acres of untimbered privately owned range land is destined for public ownership. In such areas the isolated public tracts should be leased for terms of 1 to 10 years and, with proper restrictions as to use, until the ultimate form of ownership of the bulk of all the land has been determined.

Once a decision has been reached as to which isolated tracts should be disposed of, first consideration should be given to using such land as a base for Government exchange in acquiring alienated lands within the national forests or grazing districts. The final residue not usable for exchange may then be sold or leased, as provided for in the Grazing Act.

The whole situation is so complex and so far reaching in its implications that no sales or long-term leases of isolated tracts should be made until an intensive land classification has been completed that is designed to determine on a sound factual basis the best ultimate ownership of each tract. In order to lease small tracts pending the completion of a classification and adoption of the ultimate program, it will be necessary to amend the Grazing Act to authorize leasing of tracts less than 640 acres in area.

BOUNDARY ADJUSTMENTS

Certain adjustments are needed in the boundaries between the national forests and the present grazing districts as well as additions to national forests out of the unreserved public domain. These changes, for the present at least, involve only additions to national forests in order to include outside lands of national-forest character and to simplify administration. The lands which should be so added are shown in table 74. Three-fourths of this total is needed as winter game range to supplement summer game range now inside the national forest and thereby to round out yearlong game ranges.

Legislation is required to authorize transfer of land from the grazing districts or other Federal areas to the national forests in all States except South Dakota, Utah, and Nevada. Proper correlation in the administration of the national forests and grazing districts as subsequently discussed would doubtless make unnecessary the transfer of much of the land between the two classes of reservations.

In addition to the Federal land which should be included in the national forests, approximately 10 million acres of privately owned land now outside the national forests should be acquired to simplify administration and round out national-forest-management units. Of this, 4,443,000 acres is required for game range.

TABLE 74.—*Federal land which should be added to national forests from grazing districts and unreserved public domain*

State	Recommended to Commission on Public Domain, 1930 [1]	Additional needed for wildlife management	Total public land to be added	Portions of total needed for wildlife management
	1,000 acres	*1,000 acres*	*1,000 acres*	*1,000 acres*
Arizona	2,736	500	3,236	944
California	2,469	850	3,269	1,219
Colorado	3,200	2,855	6,041	3,441
Idaho	2,151	77	2,228	805
Montana	866	41	946	69
Nevada	1,084	944	2,028	1,806
New Mexico	1,827	279	2,106	222
Oregon	884	689	1,573	1,573
South Dakota		11	11	11
Utah	2,249	625	2,884	1,723
Washington	89	69	158	188
Wyoming	1,127	449	1,577	515
Total	19,017	7,418	26,435	14,192

[1] A National Plan for American Forestry (145), pp. 644-647.

MACHINERY OF ADMINISTRATION

The national forests and the grazing districts have been established for the purpose of protecting public interests, which it is recognized will not be so protected under other forms of ownership or management. Many of the problems are technical, involving a knowledge of plant, animal, and soil sciences, agricultural economics, land-use adjustments, and, in particular, range management.

The situation calls for a decentralized administrative organization with undivided responsibility and authority to transact local business promptly. The personnel must be qualified by training and experience to handle business matters with the public and the user and to apply both the practical and the technical phases of range management in accordance with local conditions. This can best be done by a force of men in the employ of the Government.

These lands also have resources needed in the development of local communities. Each State in which the lands are located has a distinct interest in them. There is necessity, therefore, for local viewpoint to be represented in the regulation of the use of the resources to meet local needs. This voice of the local interests may best be expressed through the cooperation of local groups or associations and agencies with the Federal agencies, but the Federal Government must retain final decision on all matters pertaining to the public interest.

NATIONAL FORESTS

Of the two classes of land, the national forests, because of higher values involved, more complicated association of different resources, more difficult terrain, and greater variety of conditions and problems to be dealt with, require a more intensive and hence more expensive administration.

The cost of administration of grazing of domestic livestock on the 82,538,000 acres of used range on the national forests was at the rate of $0.0089 per acre for the fiscal years 1932 to 1935. The cost for wildlife management on this area was $0.0018 per acre, or a total for domestic livestock and wildlife of $0.0107 per acre.

Because of the pressure of other work on the national forests, range administration is not receiving the attention it should have. The range and the vital interests of dependent communities are suffering because much of the administrative time required for orderly and well-coordinated range use is being unavoidably devoted to other duties. To meet this need the administrative force on the national forests should be augmented by 125 additional qualified men for range management, at an additional cost of $0.006 per acre of used range, and an additional administrative personnel for wildlife management at a cost of $0.0042, bringing the total cost for both livestock and wildlife administration up to $0.0200 per acre.

The capital investment for improvements already installed on national-forest ranges, including range fences, corrals, stock driveways, water developments, buildings, and range surveys and management plans, exclusive of roads, is in the neighborhood of 5.8 million dollars, or about $0.07 per acre. Table 75 shows the more important additional improvements, developments, and other investments required properly to utilize and improve the resources and a proposed annual expenditure for a 5-year period to install these improvements. The total proposed additional improvements would bring the total investment in used range up to $0.2107 per acre.

This estimate does not include an item for structural erosion-control work. Work of this character is necessary only where restriction of grazing and artificial revegetation will not result in checking erosion within a reasonable time and is justified only where high

values are at stake. Examples in each of several States are shown in table 76.

TABLE 76.—*Capital investments required and annual cost of proposed 5-year program on 82.5 million acres of available national-forest range*

Project	Size of project	Total cost	Cost per acre[1]	Time to complete	Annual expenditures for first 5-year period
	Acres			*Years*	
Range surveys and management plans	[2] 20,000,000	$112,000	[3] $0.0056	5	$112,000
Artificial revegetation	700,000	2,730,000	.0031	20	136,000
Rodent control	6,000,000	840,000	.0070	5	168,000
	Miles				
Range fences	13,000	4,276,000	.0520	10	428,000
	Number				
Water developments	5,200	3,302,000	.0407	10	330,000
Investment in present improvements		5,708,000	.0699		
Total		17,328,000	.2107		1,146,000

[1] Cost per acre is the total cost prorated to the 82,500,000 acres of good range.
[2] This is total acres, to be surveyed and includes nonpermit and privately owned land mixed with usable Federal range.
[3] The cost for the 20.0 million acres actually to be covered is $0.0280 per acre.
[4] Cost per acre actually to be covered is $0.56.

TABLE 76.—*Examples of areas needing structural erosion control on national forests*

State	Type of erosion	Type of control	Area	Cost per acre	Total cost
			Acres		
Washington	Gully	Check dams	8,000	$20	$160,000
Oregon	do	Check dams and reseeding	10,000	15	150,000
California	Sheet and gully	Check dams and revegetation	2,000	25	50,000
Utah	do	Trench terraces and revegetation	1,000	45	45,000
Arizona	do	Diversion and spreading	68,000	2.5	162,000
New Mexico	do	do	1,700	3	5,100

THE GRAZING DISTRICTS

The net usable Federal range land in the present grazing districts, unreserved public domain, and other unregulated areas, all of which should be put under control in grazing districts or added to the national forests, is 149,890,428 acres. To administer this land adequately with an independent agency, including correlated use of all the resources, necessary technical services, range inspections, clerical work, and land examinations, will cost approximately $2,260,000 per annum, or $0.0151 per acre. This estimate is based upon the experience of the Forest Service. The wildlife management program for this land will cost at least an additional $150,000, or approximately $0.001 per acre.

The capital investments needed properly to develop and improve the grazing-district land and a proposed annual expenditure for a 5-year period are shown in table 77. The eventual total investment, as shown, will amount to $0.39 per acre, of which about 8½ million

dollars should be spent per annum during the next 5 years. In addition, some structural erosion-control work will be necessary, but data are not available at this time upon which to base a reliable estimate. Additional rodent-control work may be needed, depending upon the extent to which infestation may spread. The largest single item is an average of nearly $0.31 per acre for the rehabilitation of depleted range areas, which should be restored both to control erosion and increase the forage supply.

TABLE 77.—*Capital investment required and annual cost of proposed 5-year program for 149.4 million acres of available range on grazing-district land*

Project	Size of project	Total cost	Cost per unit[1]	Time to complete	Annual expenditure for first 5-year period
	Acres			Years	
Range surveys and management plans	[2] 149,400,000	$600,000	$0.0040	5	$120,000
Artificial revegetation	18,000,000	54,000,000	.3072	20	2,700,000
Rodent control	40,000,000	8,000,000	.0214	10	800,000
	Miles				
Range fences	10,000	4,000,000	.0268	10	400,000
	Number				
Water developments	6,000	3,000,000	.0202	10	300,000
Total investment		67,600,000	.3529		4,320,000

[1] Cost per acre is the total cost prorated to the 149,400,000 acres of available range.
[2] Roughly speaking, the total available range here includes some unmanaged and intermingled privately owned range, the amounts about offsetting available range which does not need to be covered.
[3] The cost for the 18,000,000 acres actually to be covered is $0.55 per acre.

COSTS AND RETURNS

Present operating cost and returns from grazing domestic livestock on the national forests and grazing districts and the estimated amounts under the essential administrative measures here proposed are shown on an acreage basis in table 78. Capital expenditures for range improvements already constructed, partly from emergency and relief funds in recent years, are not included in the present annual costs. The carrying charges for maintenance and replacement of such improvements, however, are included. The cash income from grazing on the national forests is based upon the estimated present grazing capacity and that 50 years hence and the base or average rate of the present grazing fees. The income from the grazing districts is based upon the estimated present and future grazing capacities and an assumed grazing fee approximately two-thirds that of the base rate on the national forests. The cost of maintaining improvements and the replacement charge are determined from cost records for existing improvements on the national forests. These figures for maintenance and replacements do not include any charges for artificial revegetation, rodent control, or erosion-control work. Nor is there included any item for road or trail developments, nor Federal contributions to States and counties in lieu of taxes. Furthermore, the rate charged for grazing use may change and the estimated cost of the additional improvements needed may be affected by changes in labor rates and price of material. These data are pre-

sented to afford some idea, based on the information available, of what the cost and income from the public range enterprise may be.

TABLE 78.—*Present and estimated proposed annual costs and cash returns per acre from national-forest range and grazing-district lands*

Annual cost item and income	Present grazing capacity and development status		Grazing capacity 20 years hence with proposed improvements	
	National forest	Grazing district	National forest	Grazing district
Carrying charge on improvements:				
Maintenance	$0.0037	(1)	$0.0118	$0.0039
Replacement	.0042	(1)	.0107	.0038
Cost of administration	.0099	(1)	.0149	.0181
Total annual cost	.0178		.0374	.0257
Income from grazing of domestic livestock	.0235	$0.0089	.0283	.0176

[1] Management of grazing-district lands by the Federal Government has been started so recently that administration has not yet been fully developed and improvement cost data are not available.

The principal point in these cost and return data is that the Federal range lands are likely not to constitute a source of net direct cash income. In fact, unless the grazing fees are made higher as the necessary improvements are installed, the costs will be higher than the amount paid into the United States Treasury. It will involve an increase ultimately of approximately 30 percent above the present average base rate of 14.5 cents per head per month for cattle and 4.5 cents for sheep on the national forests, and of approximately 30 percent above the assumed rate of 9.6 cents a month for cattle and 3.0 cents for sheep on the grazing districts. There is justification for such increases because the improvements installed and bettered forage conditions on the public range will result in a direct benefit to the user for which it is only reasonable that he should pay.

Moreover the solvency of the Federal range enterprise cannot be calculated wholly in terms of direct net cash income from grazing alone. In addition to the grazing fees must be considered the income and other taxes which the forage resources, when converted into marketable meat and wool, will yield on a sustained basis to the Federal Government and the various political subdivisions. The public range will also help to sustain the taxable value of related lands. Even the benefits from the range resources are not to be measured only on the basis of direct income from fees or indirect returns through taxes, because this feed supply is a link in a chain of resources, which, if weakened either by depletion or denial of use, would adversely affect the entire economic structure of the West.

Regardless of whether or not grazing on Federal range lands is self-liquidating, there are certain other individual or intangible public benefits which justify Federal ownership, protection, and management. These lands constitute a part of the great hinterland whence flows the water supply upon which is based the civilization of the western United States. What the protection and favorable yield of this resource is worth is perhaps incalculable, but, as shown in an earlier chapter, it is certainly very large. More tangible values are derived from the business transactions incident to hunting, fish-

ing, and recreational use of the land, but even these do not begin to measure the benefits of the renewed health and the pleasure derived from the human enjoyment of these areas.

Unification of Range Administration in One Department

The Forest Service, which has jurisdiction over the national forests, is in the Department of Agriculture. The grazing division in charge of the grazing districts is in the Department of the Interior.

CORRELATION IN ADMINISTRATION

Since the national forests and the grazing districts are part of a single complex agricultural land pattern, and since both classes of land must be integrated with the same farm and ranch lands, close correlation and coordination is needed in range administration. Many livestock are dependent on the national forests for summer range and on grazing districts for winter range. The same holds true for big game in many localities. Shortage of spring range on national forests may be relieved by proper adjustments with grazing districts. Where national forests and grazing districts adjoin, range improvements and range administration should be so planned as to bring about the best and most efficient utilization of their combined public resources. Neither can be safely or properly considered as a unit to be developed and administered without regard to the other.

Proper correlation and coordination would also simplify the rounding out of administrative units in both the national forests and the grazing districts and facilitate the handling of intermingled private lands. It would lead to a sounder basis for determining grazing fees. It would result in more effective use of supervisory and technical services and information. Since the main work period on the two classes of land comes at different seasons of the year, present short-term personnel could be transferred from one to the other and thus be put on a more nearly full-time basis, resulting in attracting better qualified employees. Finally, correlation in the many different phases, assuming a thoroughly efficient administration, would eliminate duplication of expenditures and result in lower cost of administration and more efficient service to the public.

Unification of administration in one department is the best answer to the correlation problem. Further advantages in unification are fairly obvious. It should eliminate any tendency for two agencies to work at cross purposes on a common problem dealing with much the same people in much the same territory. It would obviate the necessity of a range user having to deal with one Department for the summer grazing of his livestock and with another for winter grazing and having to adapt his operation to two sets of rules and regulations.

WHY THE FOREST SERVICE IS IN THE DEPARTMENT OF AGRICULTURE

The Forest Service was transferred from the Department of the Interior to the Department of Agriculture by act of Congress, February 1, 1905. This action followed a recommendation of President

Theodore Roosevelt, who, in a message to Congress on December 6, 1904, declared:

> All the forest work of the Government should be concentrated in the Department of Agriculture, where the larger part of that work is already done, where practically all the trained foresters of the Government are employed, where chiefly in Washington there is comprehensive first-class knowledge of the problems of the reserves acquired on the ground, where all problems relating to growth from the soil are already gathered, and where all the sciences auxiliary to forestry are at hand for prompt and effective cooperation. * * *

Since 1911, however, there have been repeated efforts to transfer administration of the national forests back to the Department of the Interior. No less than a dozen bills have been introduced into Congress to this end or to transfer the national forests to a new Department of Conservation. The most recent of these—H. R. 7712 and S. 2655 pending before the Seventy-fourth Congress—propose to change the name Interior to "Conservation" and to pave the way for the transfer of national-forest administration to the newly named Department. With a public range administration agency in each department, it becomes a matter of deciding in which Department the work should be grouped.

In order to lead to a clear understanding of the problem and to a sound answer to this question it is necessary first to consider what the public forest and range lands really involve and whether or not there is any valid cause for abandoning the reasoning which led to the transfer of the Forest Service in 1905.

RELATION OF FEDERAL RANGE TO OTHER AGRICULTURAL RESOURCES

The national forests and grazing districts are not merely so much range land which the Government has to protect and rent to the public, as a landlord holds a farm or range which he is willing to let to some qualified user. The ranges, as clearly shown in an earlier section of this report, are an inseparable part of western agriculture. The public range resources, for the most part, merely supplement the crops or wild forage grown on other agricultural lands. The products of these lands enter into the regular channels of distribution along with the products of all other agricultural lands. In the West, also, crop growing is dependent upon irrigation. The character and quantity of water supply in turn depends upon the protection of the mountain watersheds—the sources of the stream flow—which are mostly within the national forests—and upon the protection against erosion on the grazing-district lands, problems intimately related to the use of the land. Most of the wood supply used on farms and ranches comes from the national forests. There is also an intimate relationship in wildlife conservation between public range lands and other agricultural lands. Altogether the protection and use of the resources of the public lands play a definite and decisive part in the whole agricultural economy of the West.

How forestry and pasture management are related to other forms of agriculture is demonstrated by the situation on other than public lands throughout the United States. More than 2.5 million farmers derive part of their cash income from woodlands and forests on their farms. As shown in figure 83, the acreage in forest and grazing land on farms is greater than the acreage of all other farm

crops. Further, the forest and grazing land on farms far exceeds the total area of national forests, grazing districts, unreserved public domain, and other Federal range land in the continental United States combined.

The public forest and range lands, in view of the intimate relation with all the other problems in agriculture, are inseparable from other lands in developing a national agricultural program. The need for such a program has grown greater and greater, as pointed out by Secretary Henry A. Wallace, who declared:

> Ever since the end of the World War, agriculture has been groping for a way to adjust production to demand, a way to promote sound land use and

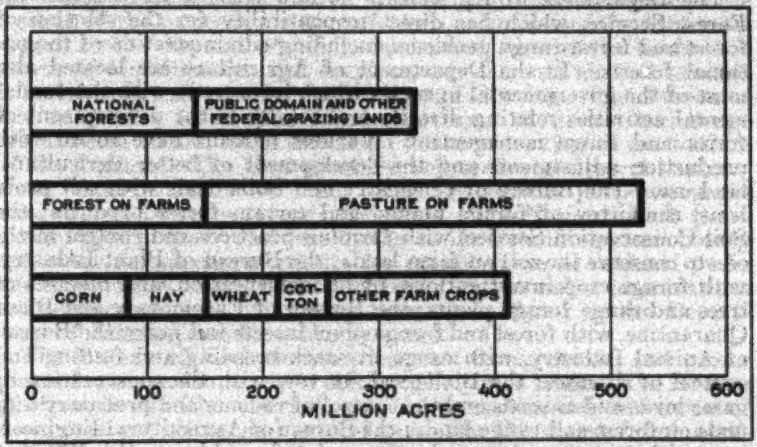

FIGURE 83.—FORESTS AND GRAZING INSEPARABLE FROM AGRICULTURE OVER IMMENSE AREAS.

Forests and pasture on farms occupy half again as much area as the national forests and other Federal range lands combined, and take up much more farm acreage than corn, hay, wheat, cotton, and all other crops.

> discourage land misuse, and a way to build a satisfying rural civilization which might serve as the greatest single stabilizing factor in modern democracy.

The Federal Government has a definite obligation to help agriculture develop a sound program. The Department of Agriculture has embarked upon such a program as one of its major undertakings. Whatever is done must deal with adjustments in land for farming, grazing, forestry, and wildlife. It will involve public land as well as privately owned farm, forest, or range land. In the West especially, public lands, in a large measure, are the very key to the needed adjustments.

FOREST AND RANGE LAND MANAGEMENT A FUNCTION OF AGRICULTURE

The management of range and forest lands is purely and simply a function of agriculture. It deals with soil, interrelations of soil and water, with plants and animals, with diseases and insect pests of plants and animals, with the planting, growing, and harvesting of crops—in fact with all the "problems relating to growth from the

soil." It must rest upon the sciences and biological laws which have to do with the soil, water, plants, and animals. It involves economic and social problems of the farmer. Conservation of the soil and watershed protection are based upon the maintenance of biological balances of plant and animal life within their environment. Research in biological phases is needed in all these related fields. Management of the public land must be supplemented by these specialized biological or agricultural technics if the job is to be done adequately.

FUNCTIONS OF THE DEPARTMENT OF AGRICULTURE

The Department of Agriculture as now constituted contains the Forest Service, which has direct responsibility for the solution of forest and forest-range problems, including administration of the national forests. In the Department of Agriculture are located also most of the governmental agencies which have to do with the fundamental activities relating directly and vitally to the development of forest and range management. Various bureaus have to do with production adjustments and the development of better agricultural land use. The Bureau of Chemistry and Soils deals with soil problems, chemistry of forage plants, and certain forest products; the Soil Conservation Service, with farming practices and control methods to conserve the soil on farm lands; the Bureau of Plant Industry, with forage crop investigations, plant identification, and diseases of trees and range forage plants; the Bureau of Entomology and Plant Quarantine, with forest and forage plant insects and pests; the Bureau of Animal Industry, with range livestock breeding and feeding and control of diseases; the Biological Survey, with the conservation of game birds and animals and the control of rodents and predatory animals on forest and range lands; the Bureau of Agricultural Engineering, with snow surveys and other related problems; the Weather Bureau, with climatological observations and weather forecasting which relate to forest and range management and fire protection; the Bureau of Agricultural Economics, with land use and production studies; the Office of Experiment Stations, with State forest and range research programs; and the Extension Service, with educational work and demonstrations for farmers and livestock growers in range management and farm forestry.

The field of forest and range management is dependent on all these lines of work in addition to the special silvical, biological, economic, and industrial research peculiar to its own field. The administration of forest and range land must have freely available to it and must freely use the services of the kind afforded by these related agencies or reduce the value of its services or increase its costs, or both.

The Department of Agriculture is the duly constituted and authorized agency of the Government to deal with the agriculturist. The livestock grower and farmer recognize it as their agency and are accustomed to dealing with it.

All of the agencies of the Department work in close cooperation with the State agricultural colleges, agricultural experiment stations, and State extension services in range and forestry, as well as in all other phases of agriculture. The activities of all of these agencies

must be closely integrated in the development and carrying out of any program of forest and range management in relation to agriculture.

FUNCTIONS OF THE DEPARTMENT OF THE INTERIOR

The Department of the Interior, as now constituted, contains the Grazing Division which has direct responsibility for the administration of the grazing districts. The work of the other agencies of this Department is much less closely related to the management of forest and range-land resources than is the work of most of the agencies of the Department of Agriculture. The General Land Office keeps the records of the ownership status of lands, administers the laws with regard to the disposal of public lands, and surveys the lands as a means of identification, and keeps records thereof; also, at present, it handles clerical work for the Division of Grazing. The Bureau of Indian Affairs looks after the conservation of timber and range resources on Indian lands incidental to the promotion of the welfare of the Indians. The Geological Survey makes geological explorations, classifies lands for other than agricultural purposes, gages streams, and prepares topographic maps. The National Park Service manages, protects, and develops areas of outstanding scenic beauty and other unique characteristics for exclusive use as national parks and monuments. The Division of Investigation makes examinations to insure compliance of existing laws administered by the Department of Interior and for other purposes.

The Bureau of Reclamation constructs dams, canals, and power plants for irrigation, many of them on the public lands. The Bureau of Mines deals with conservation in the extraction and conversion of fuels, ores, petroleum, and natural gas. The Petroleum Administrative Board is engaged in conservation in the extraction of petroleum and natural gas. The functions of these various bureaus, etc., although essential in the handling of the public lands, are only remotely if at all involved in the conservation and management of the resources of the soil in relation to the general agricultural problems of the Nation. These conservation functions of the Department of Interior—except that dealing with plant and animal life on national parks and Indian reservations which is incidental to the special purposes for which these reservations are set up—deal with the engineering, legal, and clerical phases of land administration and with the chemical, physical, and engineering aspects of conservation of the mineral or inorganic resources in extraction and conversion, and have very little directly to do with the growing of plants and animals.

DEPARTMENT OF AGRICULTURE BEST FITTED TO ADMINISTER FEDERAL FOREST AND RANGE LANDS

A basic principle of good organization in government is the grouping of related activities into combinations that will provide the most efficient, systematic, and coordinated application of the available effort to the duties to be performed. It should meet the fundamental test of being able to provide the means of attaining the established objectives. The objectives in the administration of the national forests and grazing districts are conservation and the inte-

gration of the soil, water, plant, and animal resources with other agricultural resources in the development of a program of agriculture for the Nation. Such a synthesis must rest firmly upon the specialized agricultural technique and close contact and cooperation with the agriculturist.

Conservation pervades practically every activity of the Department of Agriculture which has to do with land use or growth from the soil. Conservation of all natural resources is, however, such a broad social aim that it will not serve as a basis for logical functional segregation. To associate the forest and range resources with the mineral resources in another department would separate closely related functions in agriculture and still would not group all conservation activities in one department.

To place forest and range work in a department other than the Department of Agriculture would result in the diffusion of effort in the development of the national program for agriculture; in divorcing the national forests and grazing districts from the closely related technical activities of the other agencies; in placing forest and range work in a department with fundamentally different technics and substituting cumbersome interdepartmental action for the smooth running, informal, and expeditious procedure which now exists between the Forest Service and other Bureaus of the Department of Agriculture. It would result also in the farmer having to deal with one department on certain forest and range matters and with another department on all other agricultural matters; or else in maintaining a forestry and range agency in the Department of Agriculture.

The accompanying chart (fig. 84) shows graphically the several agencies of the two departments in relation to the federally owned public forest and range lands. The heavy or "trunk" lines radiating from the "hub" in this chart indicate the agencies in these two departments which perform technical services in conservation which are intimately related to the activities connected with the public forests and ranges. The light or secondary lines indicate the more purely clerical or less directly related functions. A far greater number of activities would have to be handled interdepartmentally if the Forest Service and Grazing Division were contained in the Department of the Interior.

The best division of functions between the two departments is on the basis of organic and inorganic resources. The organic or "renewable" resources are those which have to do with growth from the soil, with plant and animal life, and the interrelationships of soil, plants, and water. These are the resources of national forests and the grazing districts, and logically their administration should be in the Department of Agriculture. The inorganic or nonrenewable resources are the minerals, coal, petroleum, or subsurface products of the land. They largely require a different type of chemistry, engineering, and conservation in use to prevent waste and destruction and logically belong in the Department of Interior.

The national forests and grazing districts belong in the Department of Agriculture where the resources of these lands may be integrated with the agricultural resources of other lands; where the technical services pertaining to them are located; where the agencies are with which the farmer and stockman deal on all other problems

relating to farm and crop; where cooperation with the agricultural colleges is now centered; where it will be possible for one committee in Congress to handle all appropriations and other legislative matters relating to agriculture.

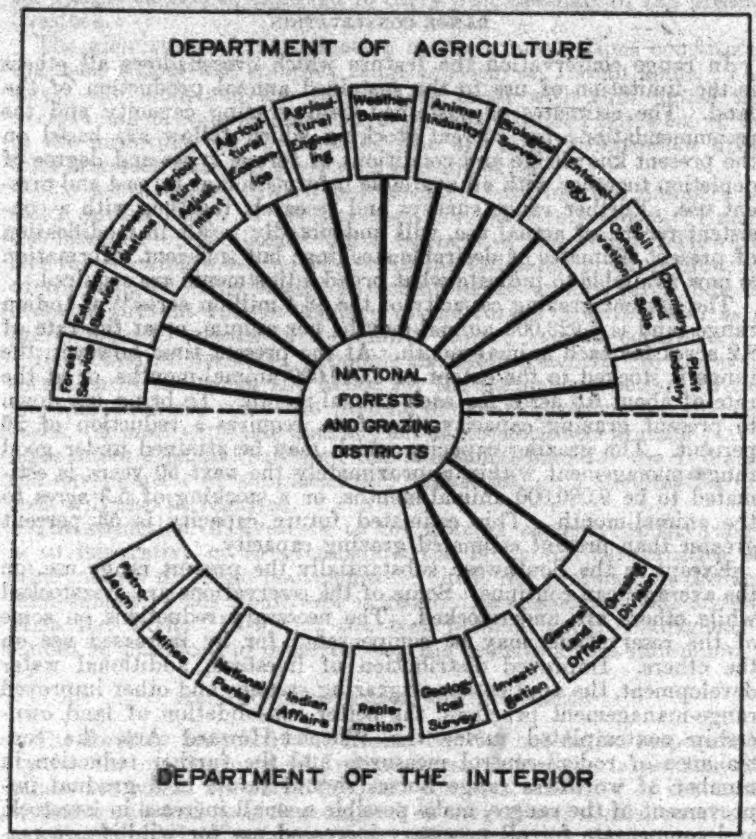

FIGURE 84.—THE DEPARTMENTS OF AGRICULTURE AND INTERIOR AND FOREST AND RANGE CONSERVATION.

Many bureaus of the Department of Agriculture are vitally and directly concerned with the biological problems confronting forest and range conservation. On the other hand, but few agencies of the Department of the Interior are so concerned.

PROGRAM FOR INDIAN RANGE LAND

Any sound program for the administration of Indian range lands must comprehend the ultimate integration of the Indian into the social and economic life of the Nation. When this has been accomplished there will be no further need for special guardianship of Indian rights nor for special care of Indian property as a separate ownership class. Meanwhile the administration of an Indian-owned natural resource should aim first toward the maximum sustained

contribution to the progress of the Indian people, and, secondly, the conservation of a resource which is of a magnitude to be of national importance. Sustained-yield management of the range resources will accomplish both these objectives.

RANGE CONSERVATION

In range conservation the feature which overshadows all others is the limitation of use to the sustained annual production of the land. The estimates of sustained-yield grazing capacity and the recommendations for current stocking which follow are based on the present knowledge and conditions of forage types and degree of depletion together with all available information as to past and present use. Further range surveys and research, together with a consistent record of actual use, will undoubtedly result in modification of present estimates of desirable stocking; but sufficient information is now available to indicate what broad adjustments are required.

The present grazing capacity of the 48.4 million acres [44] of Indian range land is 5,923,000 animal-months per annum, or at the rate of 8.2 acres for each animal-month. At the present time, however, the range is stocked to the extent of 8,049,000 animal-months, or at the rate of about 6.0 acres for each animal-month. To bring use down to present grazing capacity, therefore, requires a reduction of 26 percent. The grazing capacity which may be attained under good range management within approximately the next 50 years is estimated to be 9,080,000 animal-months, or a stocking of 5.3 acres to the animal-month. This estimated future capacity is 53 percent greater than present estimated grazing capacity.

Except in the Southwest, substantially the present range use, on the average, can continue. Some of the reservations are overstocked while others are understocked. The necessary reductions on some of the reservations may be compensated for by increased use on the others. Improved distribution of livestock, additional water development, the application of grazing systems and other improved range-management practices, the better consolidation of land ownership contemplated under the Wheeler-Howard Act, the continuance of rodent-control measures, and the further reduction in number of worthless range horses should result in a gradual improvement of the ranges, make possible a small increase in livestock, and compensate for all necessary increased use for wildlife, recreation, or other purposes. Any internal adjustments which may be required in the allocation of grazing use can be made gradually and with no serious inconvenience to the Indian livestock industry or present permittees.

In Arizona and New Mexico a very material reduction in livestock numbers is urgently needed at an early date. Every reservation in the two States with the exception of one in New Mexico and a small one in Arizona is more or less seriously overstocked. Appropriate reductions on six of the other reservations can be made without affecting Indian-owned livestock, since white-owned stock constitutes a material part of the overburden on these reservations.

[44] Includes a small percentage of nongrazing land in small scattered tracts within the main bodies of range land.

The 20 million acres of range land on the remaining 10 reservations within the two States are grazed yearlong and exclusively by Indian livestock. On some areas, to promote rapid recovery, about three-fourths of the stock may have to be removed and generally the ranges cannot be expected to carry over one-half of the present livestock.

The alleviation of this situation on these reservations constitutes the most serious and complex range problem on Indian lands. The sheep, the land, and the Indians are faced with ruin unless the overgrazing is stopped and the range rehabilitated; but what to do in the meantime for the Indians who are largely dependent upon their livestock industry presents a real difficulty.

The net progress toward permanently reducing the numbers of stock on the range as yet has been comparatively slight. Under the mandate of the conservation features of the Wheeler-Howard Act the stocking must be reduced to the estimated grazing capacity of the ranges. This should be accomplished at any early date in order to prevent further damage to the forage resources and as a prerequisite to success in the efforts toward erosion control.

Reduction of livestock, although absolutely essential for the conservation of the range and hence for the permanent welfare of the Indians, does not solve the present economic problem for the Indians. A more equitable distribution of livestock and grazing privileges offers a partial solution; but additional land for the Indians, the development of supplementary industries, or a combination of both will also be required.

The reduction of livestock to the grazing capacity of the range is so imperative as to overshadow the needs for the practice of other phases of range management. Until the overload on the Indian ranges of the Southwest is reduced, management will accomplish but little. However, the best possible range management should be practiced in order to keep the reduction to a minimum.

MACHINERY OF RANGE ADMINISTRATION

The forestry branch of the Indian Service has major responsibility for the management of Indian forest and range lands, the expenses for which are about $200,000 per year, exclusive of the costs of timber sale and special work, and of clerical and similar overhead services handled in common with other activities. A program of adequate administration calls for an increase of $290,000, making a total of $490,000 per year, which would make an annual average cost of approximately 1.1 cents per acre or 0.6 cent increase over present expenditures, exclusive of clerical work.

MULTIPLE USE

In addition to the regulation of use of forest and range lands for timber and livestock production, the public policy and Indian welfare demands that attention be given to multiple-use management to achieve watershed protection and wildlife conservation.

Protection of watersheds is of local interest in maintaining favorable conditions of stream flow for irrigation control of floods and

in maintaining a favorable environment for fish life on the Indian reservations. Watershed protection is also of national interest because many streams important to the West rise on or flow through Indian lands. It is estimated that on Indian lands 22 million acres are severely eroded and 20 million acres are materially eroded. Adequate wildlife management is of special importance on Indian lands because hunting and fishing can be made an important source of livelihood as well as recreation to the Indians. The additional administrative facilities for handling wildlife work, it is estimated will cost an extra $0.001 per acre on the average.

RANGE IMPROVEMENTS

Much of the need for structural improvements on Indian lands has been completed. During the period July 1, 1933, to March 31, 1935, 3,469 miles of range fences, 2,444 spring and well developments, 1,987 reservoirs, and 107 corrals were constructed. In addition, over 50,000 check dams for erosion control were installed. However, much work still remains to be done. An estimate of the range improvements required to be constructed over a period of years on all reservations where cattle and horses are grazed is shown in table 79.

The estimated cost of capital investments does not include an item for control of soil erosion. A detailed study of control work needed on the more seriously eroding Indian lands of the Southwest has not been completed and consequently no estimate is offered at this time of the amount or probable cost of rehabilitation work of this kind that may be needed.

Since the capital investments proposed in table 79 are not equally chargeable against all Indian reservations, a prorated acreage figure is of value only for purposes of comparison. On this basis, the improvements, revegetation, surveys, and management plans proposed and the more intensive plan of administration recommended would call for an average capital investment of 18.5 cents per acre spread over a period of years. The annual maintenance cost when the improvements are complete will be about 1 cent per acre. There appears to be no question that this full amount will be required in order to meet the mandates of the Wheeler-Howard Act.

TABLE 79.—*Capital investment required and annual cost of proposed 5-year program on 48.4 million acres of available range on Indian lands*

Project	Size of project	Total cost	Cost per acre [1]	Time to complete	Proposed annual expenditures for 5-year period
	Acres			*Years*	
Range surveys and management plans	28,000,000	$210,000	$0.0074	5	$42,000
Artificial revegetation	1,020,000	4,648,000	[2].0960	20	233,000
Rodent control	12,000,000	960,000	.0198	5	192,000
	Miles				
Range fences	5,000	1,200,000	.0310	10	120,000
	Number				
Water developments	2,000	1,000,000	.0210	10	120,000
Total investment		8,018,000	.1832		702,000

[1] Cost per acre is total cost prorated to the 48,500,979 acres of available range.
[2] Cost is $3.86 per acre actually treated.

NET RESULTS OF PROGRAM

Although the program of work and expenditures recommended for Indian lands is considerably larger than at present no other sound alternative seems possible. The future welfare of the American Indians is dependent upon a sound foundation of natural resources available in perpetuity. To the long neglect of this phase of Indian guardianship is chargeable much of the present sad plight of the Indians of the Southwest. To this neglect is chargeable also much of the cost that is needed properly to improve the resources. A good start has already been made on the Indian lands but, unless supplemented with the necessary additional work, the process of reconstructing and maintaining a suitable environment for the Indian will be too slow and will lead to greater economic difficulties.

STATE, COUNTY, AND MUNICIPAL RANGE LANDS

The 17 Western States own an aggregate of approximately 58.2 million acres of available range land within the range area as defined in this report. This land is the undisposed portion of the grants to the respective States by the Federal Government[46] together with lands which have been acquired by foreclosure of State loans and, in certain of the States, by reversion of tax-delinquent lands. In addition, counties and municipalities own an aggregate of not less than 7 million acres of available range land, most of which has been acquired through foreclosure on tax delinquency. These lands represent a considerable part of the western range resource. Up to the present the State and local public range has been administered with sale or lease as the chief objective—a policy which has failed to conserve the resources. It is estimated that the grazing capacity has been depleted approximately one-half from virgin condition and that about 28 million acres are severly eroded and an equal amount is materially eroded.

STATE LANDS

RESULTS OF PAST AND PRESENT POLICIES

As already pointed out in an earlier section of this report, lands were granted to the States for the benefit of schools and other institutions and are held in trust by the State governments. The organic legislation usually provided that, as the lands are disposed of, the proceeds must be safely invested as trust funds. Provision is made in many of the grants also that any loss to the fund through unwise investment by the State must be restored from the general taxes. In at least a number of States, lands must be put up for sale whenever an offer equal to the appraised value is made. This policy was adopted at a time when the general conception of public-land administration was one of disposal. There was little if any conception that the grant lands should be retained and administered from the standpoint of income from the sustained yield.

The grant lands which remain are little suited for private ownership at the price for which they may be purchased.[47] Where the pro-

[46] Texas retained all of its land when it was admitted to the Union.

[47] In some of the Western States the organic legislation stipulates a minimum price at which institutional grant lands may be sold. Lands having a value less than the minimum price have remained in State ownership.

visions of the grants and the present State constitution and State laws make it mandatory to offer the land for sale, the establishment of an effective management administration is discouraged if not prevented. But even in the States where the land agencies have greater latitude, little effort has been made to undertake management. In those States where tax-delinquent lands revert to the State or the State has foreclosed on mortgaged lands, the laws generally provide that the land must be disposed of by sale insofar as it is possible to satisfy the lien against the land.

One of the chief reasons for lack of effort to apply management or obtain changes in basic laws that would authorize really effective management of State range land has been the character of the administrative agencies. The land-disposal tradition early became established and the initiative to change it has been lacking.

In most of the States only a portion of the scattered sections specified in the land grants have been blocked up through lieu selections. The bulk of the lands now owned consists of scattered tracts so isolated from other State lands as to make management extremely difficult.

The urge to obtain maximum current income from the land has encouraged obtaining maximum rental from leased land and has discouraged expenditures for range conservation. This, in turn, together with the lack of security of tenure to the lessee, has encouraged him to overstock the land in order to derive returns commensurate with the price he has been required to pay.

The isolated character of the tracts, where the bulk of the adjoining land is unregulated public domain, has resulted in no income to the States from much of their land. Utah perhaps represents an extreme case. In that State only 130,000 acres out of a total ownership of over 2 million acres was leased during the period 1923 to 1932, and yielded an average annual income of only $16,058 (*150*). The major portion of the land is scattered throughout what was formerly unregulated public domain (now being included in grazing districts) in isolated tracts of 640 acres, which stockmen used free of charge in common with the Federal land because the State was unable to extract a fee or prevent trespass. The State lands were thus depleted along with the open public domain.

In parts of Utah and the other States where, through rental of the isolated State lands, it was possible for stockmen to control large areas of surrounding public domain, the returns to the State for the land actually leased have been higher than normal because the control of open public domain enhanced the rental price of the State land. However, depletion of the range in the State properties has usually accompanied the high rental prices.

POLICIES DUE FOR A CHANGE

There are several reasons why a reconsideration of the policies for State range lands may be expected. The people of the West as a whole are coming to realize that further disposal is unsound and only adds to the unfavorable ownership situation. This view is encouraged by the action at last on the part of the Federal Government to refrain from further disposal and place at least a part of the remaining open public domain under regulation under the pro-

visions of the Grazing Act. This will also facilitate State action on isolated tracts of State land surrounded by unregulated public land. The wider practice of conservation on Federal lands undoubtedly would encourage action on State lands. Many of the beneficiary State institutions are beginning also to take an interest in sustained income from the land in place of high immediate returns and an uncertain future.

Just how far each State will be able to go, however, in the better administration of its lands and continue to derive an income for the beneficiary institution will depend upon the sustained productivity of the land and the economy of administration. As already shown for Federal lands, income from much of the public range cannot be expected to exceed the cost of administration and adequate range management. When this is the case the beneficiary institution must face the problem of how to obtain the funds to replace those at present being derived from the lease of land. The necessity of some alternative appears obvious because continuation of excessive rentals which result in further deterioration will eventuate in a permanent loss of income. Each State will need to study its individual problems carefully and decide upon the course which will result in the highest benefit to the public interest in the long run.

PROPOSED METHODS AND PRACTICES FOR ADMINISTRATION

There are several methods of administration which might be followed on State-range land. One possibility is to continue to lease the land with stipulations in the lease contracts as to degree of stocking, seasons of use, and other requirements as to proper management. Inspection and enforcement of terms of a contract under such a system where the land is scattered in thousands of small tracts, would be expensive and impracticable in most cases. This plan would hardly be applicable except in case of lessees who may be relied upon to use the range properly.

Another possibility, where isolated tracts of State land are surrounded by or adjacent to Federal range land under management, is to enter into cooperative agreement with the Federal agency to manage the State land along with the Federal land and pay the proceeds, after deduction of a reasonable cost for administration, to the State. Such an arrangement is already in effect for State lands in some of the national forests and offers real promise in parts of many States.

A third plan consists of the States blocking up their holdings into tracts of a sufficient size to warrant establishing an administrative agency. Such consolidation of State land, through exchange for Federal land, is authorized for State land within national forests and grazing districts where this plan is followed.

Perhaps no one of the three systems could be made general in any one State. It might be found the most feasible in particular States to handle some land under one system and some under another. The system to follow will depend upon what is most applicable under the particular circumstances.

One of the big tasks in the management of State range lands is reductions in the present use. The present grazing capacity is estimated, based on available information and comparison with similar

Federal lands, to be at the rate of 5.66 acres per animal-month of use. Present stocking, however, is nearer 2.8 acres per head. This shows the need for a reduction in present use of approximately 50 percent. The grazing capacity, say in 50 years, with improvement under good range management, it is estimated, will be at the rate of 3.3 acres per animal-month of use, or an increase of 70.6 percent over present estimated grazing capacity. The capacity figures, of course, will vary from place to place. The figure given is an average for all State lands.

Professional management.—The change to resource management will require a change in administrative set-up in most States. Basic legislation should be enacted declaring that permanent and constructive management shall be the guiding principle in administration of the land. There should be a close correlation between the land offices and the State agricultural agencies; or better, the administration should be placed under the agricultural agency. This is necessary in order to insure the application of sound professional management and to get away from the viewpoint of maximum revenue for the present where it results in impairment of the sustained productive capacity of the land.

Multiple use.—The principle of multiple-use management should be applied on State range lands in order to derive the fullest benefits from all the resources. Over 4 million acres of forest ranges is involved. Watershed protection and propagation of wildlife is a responsibility of the State on State lands. Where wildlife production and recreational use—on which there seldom is an excise charge—will reduce other income to the beneficiary institution, some means of reimbursement from the State game or general tax funds should be developed.

Integration with agriculture.—The State range lands should be coordinated with other agricultural resources in order to obtain the highest use from all the land, as is provided in Federal rangeland administration.

Cost of administration and improvements.—Cost of administration and construction of improvements will vary with local conditions. It is estimated, based on experiences on the national forests, that, for all the Western States, the average cost for a proper qualified professional administration capable of applying the necessary technical range management will cost not less than $0.0116 per acre for use by livestock. The necessary additional cost for wildlife administration should be paid out of State game funds.

The following average cost per acre for resource surveys, management plans, improvements, etc., is estimated to be needed:

Range surveys and management plans	$0.0053
Range fences	.0480
Water development	.0133
Revegetation and restoration (acres actually treated)	2.05
Rodent control (acres actually treated)	.03

These charges would be necessary whether or not the lands are blocked, since if left in scattered tracts the States should pay a pro-rata share along with the other agencies whose lands share in the benefit from the improvements. As pointed out in a later section of this report, the States should also undertake a share in the research

problem necessary to solve many of the problems in range management.

Much of the county and municipal land is leased or rented and some of it is a no man's land open to free use. Practically all of it is badly depleted and becoming worse. The county ownership is being added to continually in those States where tax-delinquent lands finally revert to the counties. The appalling situation being created by tax delinquency on range and dry-farm lands has been discussed in an earlier section of this report.

The long time required in most States before governmental agencies finally take title to such lands makes it difficult to determine how large an acreage will eventually pass on to public ownership, but it is generally recognized to be large. One of the chief problems in this connection is to speed up the process whereby lands which have been abandoned and are definitely known to be unfit for private ownership will become public property. During the intervening period these areas are subject to all sorts of abuse. Shortening the period of recapture would reduce the extent of injury and shorten the time before rehabilitation could be started.

The extent to which there is a place for county or municipal ownership and management of range land unsuited to private ownership will depend upon circumstances in individual cases. The larger, stronger counties or cities may be able to undertake the work on a satisfactory scale. Others will probably not be able to set up properly qualified agencies to handle such properties adequately, at least on a permanent basis, and may decide to turn the land over to the State or the Federal Government in order that it may be managed by agencies better prepared to do the work, under such terms or reimbursement as are found proper. One important possibility for counties or municipalities deciding to regain range land is to enter into cooperative agreement with State or Federal agencies to administer the land along with other public land and share in the receipts. In some instances lessees doubtless can be found who will utilize the land under proper restrictions. Action will vary widely, depending upon particular circumstances, but definite provision should be made to prevent further deterioration and to restore the forage values.

Legislation Needed

The proposed program for the several classes of public lands will require certain modifications of present legislation and some new legislation, both Federal and State. These needs are summarized in a later section.

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PRIVATE OWNERSHIP—LAND AND LIVESTOCK

By George Stewart, Senior Forest Ecologist, Intermountain Forest and Range Experiment Station; W. G. Koogler, Senior Range Examiner, Southwestern Region; and W. R. Chapline, Chief, Division of Range Research

Present Condition of Private Lands

The continental United States contains 1,903,216,640 acres of land, of which 975 million acres is in the western range region. Approximately 721 million acres of the latter area consists of usable and available range land; 376 million acres is held in private ownership. These lands passed from public to private ownership through a series of land-disposal laws, which imposed no restriction on their use, either direct or implied. In the 50 to 80 years of occupancy, and during the period of transfer to private ownership, both the character of the original cover and the productive capacity of the land have been greatly changed.

The luxuriant forage supply of the virgin range is now depleted until, on the average, these 376 million acres of private land produce only 49 percent as much feed as originally. Approximately 88 percent have been depleted in excess of 25 percent. Excessive stocking prevails on most of the area. Watershed values are not protected and inadequate water supply, abnormal erosion, and floods constitute a menace to farms and communities. Much of the area is suffering from economic instability. These adverse social and economic conditions require correction. The solution of the problem rests mutually with the private owner and governmental agencies.

What Private and Public Agencies Can Do to Stabilize Private Ownership

The stabilization of private range-land enterprises will require the united effort of landowners and of various public agencies. Even with the transfer of 125 million acres of range and crop lands to public ownership, as previously recommended, the total range land in private ownership will still remain high. To insure the sort of private ownership which will meet its responsibilities, many of the existing disadvantages must be removed through a consciously planned program. Such a program involves: (1) Recognition of the stewardship of land; (2) solution of the submarginal land problem; (3) development of socially sound economic range units or their conversion into profitable ones; (4) reduction of inflationary land values; (5) practice of range management, animal husbandry, and game management; (6) control of production; (7) overcoming marketing handicaps; (8) improved credit facilities; (9) more equitable taxation; and (10) research and extension.

STEWARDSHIP OF LAND

Since the establishment of the first colonies, America has pioneered through a vast empire and conquered a wilderness in the process. Traditionally, the desire to open up virgin territory, creating larger economic opportunity and independence, has been a prime motive of agricultural development in its migration from east to west. History of this country reflects the eternal quest for greater opportunity and more fertile fields. Essentially, Americans have responded to this urge and have never been rooted fast in any one place. Under these conditions it is not surprising that the concept of stewardship of the land has been largely undeveloped.

Another reason why we, as a nation, have failed to subscribe to any theory of stewardship of the land has been the firm belief that natural resources were unlimited, and that one could move from place to place at will and untrammeled. The tradition that the owner of the land has unrestricted and inalienable rights has been woven into our legal concept of land ownership. On the other hand, the desire to hold and to build up landed property in one family from generation to generation is lacking. Land laws have been so administered as to pass much land from public ownership that private ownership cannot carry. Rugged individualism of the pioneer landholder has been in itself another contributory factor.

The point of view has prevailed that land is a temporary source of income and that ranch and range may be sold to the highest bidder if the price is right. The exodus of Iowa farmers to southern California, when land values in Iowa reached inflationary or "boom" figures, is an excellent illustration of how weakly rooted American farmers are in any region or on any piece of land.

Before much progress can be made in restoring depleted ranges and in maintaining their productivity, the stewardship concept of land must become more firmly woven into our national philosophy. Many trends in that direction are evident. Only when it is generally recognized that the natural resources are exhaustible, that soils can be dissipated, and that no other great tracts of fertile lands are open to conquest, can appreciation be capitalized that private ownership carries with it implied responsibility in land ownership. This trend is reflected in the movement that recognizes community interests in land which here and there has expressed itself in local laws regulating the use of lands. The latest outstanding expression of the stewardship concept is the development of the land-planning machinery in many States. It is predicated on the basic premise that mutuality of public and private interest exists, demanding self-imposed restrictons to preserve and develop the resources of the land.

The private owner must accept this challenge and cooperate in local and regional organizations which seek to develop sound land policies and the machinery to effectuate them. Without the hearty support of the body politic, no land planning can be imposed by governmental agencies. Machinery, which the private owner can skillfully use in this movement, already exists in such organizations as the Farm Bureau, the Grange, cooperatives, and similar groups.

The public must recognize that acceptance of stewardship of agricultural and range lands will develop but slowly and weakly until agriculture is given a fair opportunity to market its products at levels above the cost of production. Onerous taxes and burdensome land-carrying charges discourage the ownership of farm or range lands. The public must also provide the legal machinery and instrumentalities for collective action in zoning and land planning which will designate areas that can best be held in private ownership, lands the ownership of which is now doubtful, and lands that must be retained in permanent public ownership.

SUBMARGINAL LANDS

A large area of range lands is so handicapped by low productive value or other disadvantages as to render these tracts submarginal for permanent private ownership, although they may possess attractive potentialities for range use under public ownership. Lands of such low quality, that their income is inadequate to cover the costs of private ownership, must ultimately be classed as submarginal. However, lands submarginal in character may prove temporarily profitable during very favorable price cycles, only to revert to their true status with the return of average prices, or when other unfavorable conditions develop.

Private owners have frequently failed to recognize the submarginal character of their holdings and have hung on doggedly against odds; eventually, however, they invariably succumb. The most difficult situation that arises is where the livestock producer attempts to maintain lands in private ownership whose carrying charges become so burdensome, with returns so uncertain, that his available capital is practically exhausted by indebtedness.

The sterling ability of the pioneer to struggle against difficulties is futile when an attempt is made to stem the overwhelming odds encountered on such lands. Difficult as it may be, the individual personally must recognize the limitations in the private ownership of low-productivity land.

Definite responsibilities accrue to the public regarding submarginal lands, especially if their condition adversely affects watershed protection, wildlife, recreation, or other public values. In many instances the toll of severe depletion has metamorphosed many tracts from desirable range lands into financial stalemates. Vast areas, depleted in excess of 50 percent and now submarginal, require rehabilitation. In many cases, the private owner is unable to bear the cost of such improvement. If the public has to pay the rehabilitation costs, it should undoubtedly reap such benefits as may obtain.

The public is not conferring a favor on the stockman, who is trying to operate on privately owned low-value land, foreordained to failure, by extending to him special financial assistance and other subsidies, except as a temporary expedient. It would be preferable for the public to acquire the land and permit its use under such supervised management as will restore values and sustain production. Stockmen, who own productive ranch property which can be used to advantage with the publicly acquired range land, should be accorded opportunity to use such acquired land under a preferential system similar to that now applied on the national forests. Accordingly, submarginal lands should be passed to public ownership as

rapidly as possible. Every possible means should be utilized to prevent submarginal lands now in public ownership from falling into private hands and further complicating an already unsound situation.

These lands cannot be taken over immediately. It may require up to 50 years for the entire 125 million acres of submarginal range and dry-farm land of the West to be acquired. It would be regrettable if a conscious program could not be undertaken promptly and carried forward aggressively, because of the waste of resources, human effort, relief costs, and other features that prevail under present conditions. It is a big problem, the answer to which is not yet clear. Three possibilities present themselves: (1) The tax delinquency route; (2) gifts; and (3) outright purchase or exchange.

An unknown area is already tax delinquent and can be immediately taken over by counties and States. Several million acres of such submarginal land have already reverted in this manner. More will become tax delinquent as owners recognize its true submarginal character, or as their financial resources become exhausted.

Gifts to public agencies will undoubtedly come primarily from corporations and other large land owners. A considerable acreage is held by corporations which are unable to realize a profit or in some instances even taxes from the lands. In certain localities, such as the red desert in Wyoming, alternate sections of low-value lands within a railroad land grant are leased or owned, making it possible to utilize the intermingled public land. When fees are charged for grazing the public lands the incentive for paying relatively high lease costs will be removed, and the true value of these lands will be disclosed. Undoubtedly it would be to the advantage of owners and the public if most of these low-value lands could be given outright to public agencies qualified to administer them in the public interest. In most instances, however, the grant of lands to public agencies will probably be conditional, permitting the utilization of the resources without cost for a limited period.

Despite these means of acquisition, the bulk of the lands which should be acquired will have to be through purchase or exchange. Where relatively high-value range lands are available as scattered public holdings there would be certain advantages accruing to the public from the exchange of these for a larger acreage of privately owned low-value lands. Here again only a rather limited acreage can be obtained in this manner. A large part of the submarginal lands that should be purchased will not be recognized as such by the present owners. The many 640-acre homesteads, owned but abandoned and held in the hope that a sale can be consummated, clearly indicate the lack of appreciation of their submarginal character. Where the owner is willing to use his own capital to finance retention of such lands the public need not be concerned in immediate purchase so long as the public interest is not endangered by misuse.

Pending purchase of lands, the private owner might waive management to the Government and in return might be permitted to stock the range to grazing capacity of the land or be given such fees as are collected, less administrative costs. This privilege should be exercised only as a temporary expedient.

Some of the better lands will continue in private ownership until the public needs for the land become more acute. This will hold true especially of lands that may later be needed for enlarged wildlife and recreational requirements of the future. The public could well afford to aid in the rehabilitation of such lands pending the time when it will assume ownership.

All of these various contingencies stress the need for adequate classification of range lands to determine which areas should revert to public ownership and which parts or classes should be given priority in purchase in order to aid in the solution of the submarginal land problem.

DEVELOPMENT OF SOUND ECONOMIC UNITS

On some range lands which have sufficient productivity to justify private ownership, oversettlement has occurred on such a scale that many of the units are so small that production returns are inadequate even for satisfactory living standards. This is a real problem in many parts of the West, where communities have been promoted, which, however, lack adequate opportunities for local residents to gain satisfactory livelihood from the combination of crop and range agriculture. Range lands are limited and crop lands are also either limited or are otherwise incapable of producing the forage or cash crops necessary to make all the ventures economically sound.

In contrast to these small units, some of the unusually large outfits have failed to produce satisfactory net returns. Other large outfits make inefficient use of irrigable lands and induce other undesirable social aspects.

When all sources of income including those from livestock, crops, and outside labor are sufficient to maintain a family in ordinary times, at a reasonable standard of living, the farm or ranch may be considered to constitute a family-sized economic unit. This is a highly elusive entity, because it varies widely with the combinations of livestock and other enterprises commonly found in a locality as well as with the standard of living recognized as satisfactory in a given community.

Granting a more or less definite standard of living, a ranch which may yield good returns at one phase of the price cycle frequently fails to pay when prices slump. Probably the minimum unit that can be called satisfactory is one which will support a family in reasonable circumstances during normal periods and which will sustain itself without public relief during economic depressions.

Although many variations in the size and character of ranches that are economically or socially unsound occur and an integration of one class into another is common, three rather typical situations appear throughout the West: (1) The undersized cash crop-livestock unit; (2) the small livestock unit; and (3) the unusually large outfit primarily developed for the production of livestock. If adequate range were available the solution would not be so difficult. Practically all range areas are now congested; the resultant forage depletion has accentuated the situation and increased the difficulties of correction.

UNDERSIZED CASH CROP-LIVESTOCK UNITS

Diversification, such as results from the combination of cash crops and livestock production, facilitates economic soundness. Where soils are productive, climate favorable, and markets reasonably accessible, particularly if irrigated land is included, diversified ranches are economically sound. A family-sized unit, both balanced and diversified, is reasonably secure if the range livestock enterprise is of fair size and an income also results from cash crops. The diversified crop-livestock unit has perhaps the best chance of any in the West of becoming both economic and permanent. However, many ranches which now derive their income from the combination of cash crops and livestock operations are unsound, either because of inherent small size or lack of proper balance in the operation.

Some of these ranches are uneconomic because of their extremely small size, having only a limited acreage of cropland and a few head of cattle, sheep, or goats. The herd or flock is too small to furnish a suitable income. It is either impossible to graze additional livestock on the range or the cropland is so restricted that sufficient supplementary feed cannot be provided. In most instances the amount of cropland is the limiting factor.

Where such small farm-livestock units, which are now unprofitable, are located close to large centers of population and the cropland is suitable, a shift to production of truck or other specialized crops might make them economic. Under such conditions the principal income, including much of the food for the family, will come from the farm, range being used only for grazing milk cows or a few other domestic animals, yielding a little ready cash. Furthermore, where small units are so located that the owner can obtain a part of his income from outside labor, many otherwise unsound establishments can undoubtedly be maintained. If specialty crops are grown or other labor has to be performed, a little care can be given livestock run on the range. Livestock run at will, however, seldom yield a profit and ordinarily damage public interests. Some cooperative plan for the effective management of the livestock while the owner is busy at other work or is engaged in crop production on his farm is essential. Although cooperative management succeeds well in Utah, it has not worked out as satisfactorily in other localities.

Lack of social and economic soundness among other crop-livestock ranches ordinarily emanates from such features as the attempt to graze more livestock than the range will support, necessitating forage-crop production on land that could better be used for more valuable crops; inadequate provision for management of the livestock grazing on the range, thereby limiting production returns; and, in some instances, from a total lack of livestock or an inadequate number of range animals to properly balance feed production from harvested crops. In the majority of these cases the solution is obvious.

In the case of units which need more range livestock in order to form properly balanced operations, the purchase of additional livestock already on the range may be necessary. Nothing would be gained by further congesting overstocked ranges with shipped-in livestock.

In some instances, public range may be made available to supplement crop production on these diversified ranches by reductions in the numbers of livestock of large outfits already grazing on the public lands. Considering that practically all public ranges are now overstocked and depleted and that a high percentage of such reductions as can effectively be made within the next few years will undoubtedly be needed to give the range forage plants the opportunity to develop vigorous growth, the possibilities of improving the situation on these diversified units in any such manner are exceedingly slim unless they have livestock already grazing on the public range. In some localities, however, immediate assistance can be given.

Where such adjustments are impossible, the ultimate public good will be best served by the gradual movement of families from such unprofitable units to suitable irrigation projects, under some similar program to that now being conducted in various parts of the West by the Resettlement Administration.

SMALL LIVESTOCK UNITS

In high altitudes, on alkaline or other unproductive soils, on slopes too steep for cultivation, and far from railroads, ranches have small chance for cash-crop production. Under such conditions crop land can best be used for forage-crop production. Livestock graze on private or public ranges part of the year and are fed hay and other home-grown ranch roughage during winter and other critical periods. Many such ranches have an insufficient number of livestock to furnish a satisfactory income, although the available range and other forage resources are used to the maximum; this results in a serious social and economic problem. In some localities, one possibility for improving conditions is to distribute the grazing privileges of the larger outfits on public lands among the smaller. If this would expand the more suitable of the smaller outfits sufficiently to assure a reasonable standard of living for most of them, such a plan, where possible, would undoubtedly be desirable. However, in many instances, the number of small unprofitable units is so great that to distribute the grazing more or less evenly among them would simply reduce all to an unsound basis. Therefore, adjustments in public-land grazing privileges should be made, not with the idea of endeavoring to sustain all units, but rather to facilitate the maintenance of the number that are economically justified in each locality.

Under such conditions some ranches have expanded into units of economic size through consolidations or other means. This is especially true in the foothill region of central California where many of the original 160-acre homesteads are now combined into units of from 2,000 to 4,000 acres.

Undoubtedly, the tendency will be for the better-managed outfits to absorb those operated with less skill, and thereby gradually result in fewer and larger units, better adapted to furnish reasonable living standards. The inescapable fact must be recognized that there is insufficient range land adequately to accommodate the demands of all the existing livestock producers and their families, even

if the large ranch units were dissembled and redistributed. The general trend, in which the smallest outfits are finally absorbed by the medium-sized units, will partially ameliorate conditions. When absorption comes as a result of bankruptcy and foreclosure, considerable suffering, on the part of those who are closed out, is entailed. The planned removal of part of the families on small units to irrigated areas or to other subsistence projects should greatly decrease the losses and mitigate the pangs of pauperism. A responsibility rests on the private owner of such uneconomic units to accept these trends in adjustment.

As is the case in the small crop-livestock units, where supplemental work for owners of small livestock ranches can be made available on public land or otherwise, such supplemental work should facilitate the maintenance of many more successful homes than would otherwise be possible. A great deal of the work on fire suppression, improvement, and development of the national forests is handled by owners of this class of ranch. This supplemental income favors the retention of these otherwise unprofitable units and simultaneously provides a local, immediately available, labor supply. An extensive permanent program of conservation and development on range and forest lands is justified for this express social purpose. Such a program can take the form of tree planting, timber-stand improvement, artificial reseeding, watershed improvement, and the construction and maintenance of essential physical developments, including fences, water developments, and the like.

UNUSUALLY LARGE LIVESTOCK UNITS

Another situation exists, as in parts of Nevada for example, and, to a certain extent, in other sections of the West, where large operators have acquired irrigable lands along streams, thus obtaining a practical monopoly of large areas of public range lands. These large outfits are often economically sound and the personnel employed in their operation enjoy reasonably satisfactory living conditions. Where such large outfits make inefficient use of irrigable lands and induce undesirable social aspects, such as shifting labor and men without families, homes, or moral anchorage (*6*), the public would benefit by such adjustments as would improve conditions. Although the process of such attainment is yet indefinite, land-planning agencies might appropriately consider ways and means of bringing about a gradual adjustment, which will enable the range and crop lands in such situations to support a larger number of successful home units.

Economic stress of recent years has caused the breaking down of a number of the especially large outfits of the West into smaller units, each of which can now be accorded the individual managerial attention essential for success. This is undoubtedly a desirable trend. A gradual reduction in the numbers of livestock grazed by large outfits on public lands to facilitate the development of more successful home units will also redound to the public interest.

No attempt has been made to present all situations which tend to develop or perpetuate uneconomic units. Ranches differ radically in nature and extent, in area of land used, in size of herd, and in

total investment. The ability of these various-sized units to maintain satisfactory social and economic conditions and to enable the private owner to assume the responsibilities which the public has a right to expect from private ownership, varies greatly between regions and even within the same region. The situations must be considered from the local, regional, and national aspects and programs developed to meet the specific conditions.

Economic distress and maladjustments, because of the prevalence of uneconomic units, vary from region to region, but the problem is common throughout the western range States. Readjustments cannot be accomplished abruptly. Aid must be provided in the form of public work as a temporary or permanent expedient, to absorb the shocks of necessary economic changes.

In the western range States where public range is available, either in national forests or grazing districts, the Government can facilitate the correction of many uneconomic units: (1) By preference in the use of public grazing lands, such as is given the resident home builder on national forests, and (2) by preference in the opportunity to obtain work on the public property. Governmental agencies can also provide reasonable credit facilities through which capable small livestock operators can secure funds to buy out other small-unit operators, thus expediting the build-up of more economic units.

Considerable increase in grazing capacity may be anticipated on ranges through better management. This would improve the situation because: (1) A smaller area of range lands will then be needed to support a given number of livestock; (2) these livestock will produce more young and make better gains and therefore yield larger returns; and (3) the greater feed assurance from the improved ranges will facilitate stabilization by reducing fluctuations. Thus, available ranges will serve the ranches which remain more effectively.

The economic family unit of the future will probably be a combination crop-livestock enterprise, in which the use of public land—if any—by private owners of livestock may be the integrating balance. Small outfits will undoubtedly be able to reduce costs through cooperative effort by using the public range in common as already occurs on many existing community ranges in the national forests. The ideal combination of low-value lands in public ownership and high-quality lands in private ownership should be very effective in stabilizing livestock production and crop-agriculture. It is unlikely that any single answer will suffice for all regions and conditions, and much more factual information must be available before a definite solution can be offered for a particular locality.

INFLATIONARY LAND VALUES

Inflationary land values cannot be continued indefinitely. The sooner debtors and creditors alike accept deflation in speculative land values and write off fictitious "paper" values, the sooner will livestock producers be able to meet the land-carrying charges of private ownership. Stable private ownership is easily upset by too easy credit and boom psychology; difficult though it be, bankers and land owners must eternally be on guard to thwart it.

Public agencies, through credit facilities are now in a better position than ever before to direct and control the stabilization of land

values. The Federal Farm Credit Administration, through its many subdivisions, can bring about loan policies which will prevent foreclosures of well-managed outfits, heavily mortgaged for depression periods, but fundamentally sound under normal conditions. State and Federal research agencies have an inherent responsibility to formulate specifications by which land values may be related to actual earning capacity and which should markedly influence land transactions and the viewpoints of private credit agencies, the buyer, and the seller of lands.

RANGE MANAGEMENT, ANIMAL HUSBANDRY, AND GAME MANAGEMENT

A large number of stockmen have, for one reason or another, failed to practice good range management; as a result, the forage shows an average depletion of about 51 percent. Conditions have led stockmen to overstock during boom periods and to hold their livestock during periods of deflation. Frequently, only partial use has been made of good animal-husbandry practices to reduce costs and to improve livestock quality. Opportunities for game management have seldom been considered.

WHAT THE PRIVATE OWNER CAN DO

The insidious process of range deterioration has "crept up" on the range owner. No pronounced improvements can be effected until the range-land owner learns to recognize some of the earmarks of this process on his range and the resultant unfavorable conditions produced. Unless the owner understands that the key forage plants are disappearing, that the rich topsoil is being washed away, and that gullies are devastating valuable lands, no opportunity is afforded for corrective measures, even though he has felt the severe sting of markedly reduced income. The livestock producer must also recognize that the range can be improved and ultimately built up to some approximation of its original forage capacity only through proper range management. The most effective way to assure improvement is to determine the objectives toward which management should be pointed, the necessary action to carry out these objectives, and ways and means to secure accomplishment. In short, it means the development and application of range-management plans.

One obvious reform which the private owner should institute immediately is to correct excessive stocking where it prevails on his lands, either by reductions in numbers grazed or by such seasonal or other changes as will accomplish the purpose. In most cases, such action would produce meat and other animal products at greater profit, partly through better calf and lamb crops and reduction of losses, partly by more efficient animal growth, and partly by curtailment of supplemental feed requirements, already demonstrated as costing much more than range forage. Failure to correct overstocking will cause the undermining and ultimate collapse of the range-forage resource upon which the perpetuity of the operation depends.

Unquestionably, the private owner can improve his status by better breeding, feeding, and other animal-husbandry practices. Many of the more progressive stockmen use good quality bulls and rams, limit their breeding seasons, and provide adequate supplemental

feeds and necessary concentrates to offset low-quality range feed and present lack of necessary mineral nutrients on the range. However, a great many stockmen still use sires of medium quality and on some ranges scrub bulls even now prevail. In the Southwest, bulls are often permitted to run with cows yearlong which impairs their breeding ability and calves are not uniformly developed at time for sale. Aged cows and ewes are not culled as promptly as advisable. Seldom is adequate feed available to satisfy demands during unusually severe winters and periodic droughts.

Adequate use of supplements is, of course, essential. Supplemental feeding, however, is more costly than range forage. It is important, therefore, to coordinate the use of range and other feeds so as to reduce the winter maintenance costs as much as practicable. The carry-over of a reserve of hay or other roughage is likewise necessary in Western ranch operations because of drastic climatic fluctuations with reduced range feed in dry years and deep snows during severe winters. It is at such times that feed prices become exorbitant, and unless a reserve supply is available to meet such contingencies, the profits for several years may be wiped out in a single season.

The solution of these animal-husbandry problems appears more or less obvious, still, they persist. Adoption of better practices would greatly aid in increasing calf and lamb crops and improving quality and salability of the animals. This in turn would make it possible for owners to obtain equivalent or even greater income with fewer livestock and thus would assure more conservative grazing which would reduce the need for heavy supplemental feeding every year.

Included in the range area is over 25 million acres of privately owned land capable of producing commercial timber crops. Under proper management livestock can ordinarily be grazed without jeopardizing the use of the land for timber growing. Timber growing on this land, in many instances, will be more profitable but grazing leases can be made to help carry current costs of protection, taxes, etc. On the 24 million additional acres of poorer forest land suitable for grazing which is in private ownership there may be important cordwood, watershed, and other values. In most instances, these will be safeguarded if the lands are managed to restore depleted grazing values and to sustain forage production of improved ranges.

The full opportunities for cooperative effort have not been exhausted in fostering better range management and range improvements as well as in the reduction of costs in handling range livestock. Livestock associations can render a great service by sponsoring such cooperative effort. Many examples of the beneficial results from cooperative handling on the national forests might be cited, such as in Utah, where it has attained efficient development. The degree of success attained, as well as the possibilities in the operation of the Montana laws providing for cooperative grazing districts, merit detailed and careful study.

Improvement of range conditions and better range management hinge, in some instances, on cash outlays for revegetation and for facilities such as water development and fences. It is estimated that on the 376 million acres of privately owned lands the following ex-

penditures will be required: Water development, 3 million dollars; range fences, 6.2 million; revegetation, 48 million; and rodent control, 6 million. A considerable part of the cost of these improvements will be carried by the personal time of the owner or by part time of labor employed anyway. Some assistance of governmental agencies on these improvements is also justified.

WHAT THE PUBLIC CAN DO

The United States Department of Agriculture and the State agricultural colleges have accorded far less attention to range management than to crop-agriculture in the western range States. However, during the last 8 to 10 years, some systematized effort along that line has been inaugurated. The complexity of the problems and the large public values involved warrant a more intensified attack, both in research and extension.

If the capital investments mentioned above are made and a good forage cover established, important public values and benefits in favorable watershed conditions, and in establishment of desirable habitat for game will simultaneously be secured. Hence, public assistance may well be warranted. Possibilities include a public subsidy for seed or planting stock for revegetation and erosion control; investigations of management and revegetation; explorations of water sources; and extension of credit on a long-time amortization basis. With the gradual taking over of the 125 million acres or so of range and submarginal cultivated areas recommended in a previous section, one of the first efforts after acquirement will doubtless be the development of such improvements as are necessary to assure restoration of forage values, primarily by the public agencies.

The recent decision of the Supreme Court held it unconstitutional for the Federal Government to regulate agricultural production on private land through the Agricultural Adjustment Administration, in accordance with the provisions of a cooperative agreement between the Government and the owner. This ruling may handicap the highly imperative program in range rehabilitation on private lands, as one of its primary requirements should be that the landowner practice good range management in order to qualify for Federal assistance and to assure solvency of the public investment. States should share in this responsibility, although most States in the range region have low public incomes.

Some areas in private ownership are so inferior in natural productivity and have been so badly misused that the costs of restoration can never be justified in private ownership. These lands, in many instances, must be restored to good condition in order to conserve public values; accordingly, the safest policy seemingly requires acquisition, restoration, and administration by the public.

PUBLIC COMPENSATION FOR GAME MANAGEMENT

Private ranges support much game and in many places could advantageously maintain even more wildlife. Adequate provision for these game animals sometimes requires sacrifice of part of the forage which could be used by domestic livestock. Where game is hunted by publicly licensed nimrods, the States and sportsmen's associa-

tions may well consider compensation to landowners for such services. This can be met, for example, by providing fees to the landowner, as is done in Nebraska, where the hunter buys scrip, which he gives to the owner of the land where he kills game. Several other States also provide some form of compensation for owners. Increasing game for its aesthetic values may properly be considered as a public responsibility for compensation to private owners. In consideration of such public aid, the States can require affirmative plans of game conservation.

CONTROL OF PRODUCTION

Manufacturers and other organized producers of consumers' goods can limit their output reasonably well to suit the demand; livestock producers, lacking adequate organizations among the many independent units, have not, prior to the Agricultural Adjustment Administration in 1933, maintained production in relationship to consumption requirements. However, even under this administration no attempt has been made to control the production of range cattle or sheep. It is wholly impossible for stockmen to cease operations even temporarily, as animals have to be fed and cannot abruptly be snuffed out during a depression. In fact, the depression may, and usually does, result in holding unsalable or low-value animals on range lands; this, temporarily, may even increase production.

Radical changes in markets have taken place. Even before the World War the export demands steadily declined. The decrease in American foreign trade in range products is shown by comparison of averages for the 4-year period ending June 30, 1926, with the 4-year period terminating June 30, 1935. The excess of exports over imports in "meat and meat products" dropped from 269 million dollars in the first period to 49 million in the second, or to 18 percent. In "miscellaneous animal products" the decrease in net imports was from 29 to 7 million dollars, or to 26 percent. "Wool and mohair" shows net imports in both periods, but decreased from 122 to 15 million dollars, or to 12 percent; "hides and skins" also showed a decrease in net imports from 93 to 33 million dollars, or to 36 percent.

A continuously expanding home market, characteristic of the country before the disappearance of the western frontier, no longer exists. Immigration has been materially restricted; greatly reduced exports, following the World War, have changed our former demands. Competition from other livestock-producing countries further complicates the problem. These factors indicate the desirability for control of unmanaged surpluses, gaged to meet home and export demands. Irrespective of what form production control takes, cooperative effort of the producer will be needed for intelligent and effective administration of the machinery used, an activity in which the livestock association can aid measurably.

What the public may consummate in production control through voluntary cooperation is still problematical. Various factors and unmanaged surpluses emphasize that control of production is a problem which requires serious consideration by both the private owner and the public. The name for production control may

change; legal necessity has changed its form and may do so again; but the loss of most of the export market has made permanent the essential need for avoiding unmanageable surpluses.

MARKETS

Western livestock producers are subject to marketing handicaps due to their remoteness from markets, high transportation rates, costly feed and handling expenses in transit, selling commissions, market differentials, impersonal marketing services, and the common market gluts. Cooperative marketing is an outgrowth of widespread dissatisfaction and exemplifies the determined effort of the livestock and wool producers of the West to solve their marketing troubles.

The stockmen may still better fortify their position by further cooperative expansion through marketing services, such as those furnished by national, regional, and local marketing associations in connection with grading, selling, shipping, feed and handling costs, legal services, and credits. Better breeding and grade standardization of livestock, wool, and mohair will also aid. This strengthening of confidence between the producer and purchaser by uniform grading methods will probably result in reduced marketing costs and improved prices. Much may be accomplished by encouraging and developing the direct-contact selling method that is gaining favor in the West, through the medium of neighborhood pools and auctions which sell direct to buyers who accept delivery on the farm, or ranch, or at the local railhead.

A full recognition of the necessity for prompt movement off the range of natural increase and other livestock that has attained market maturity should prove helpful. The carry-over of animals in market finish has generally proved unprofitable to producers and injurious to overcrowded ranges. It also contributes to market instability, increased feeding costs, reduced calf crops, and other range, market, and production evils.

Public aid in helping stockmen solve their market problems has been facilitated by definite committal of the Federal Government to the principles of cooperative marketing, through the development of public highways and agricultural extension. Additional public assistance is needed for studying freight rates, market differentials, production and market distribution, price fluctuations, and the application of direct-extension methods to keep stockmen abreast of the times in livestock improvement and in the quantitative and qualitative demands of the trade.

CREDITS

Weaknesses in present commercial credit methods and banking practices work hardships on producers. These include the negotiation of short-time loans where the nature of the operation precludes consummation of the project before loan maturity, and high interest rates with the virtual compounding of interest at frequent maturity intervals. Loan agencies have also often been liberal in credit during boom periods and extremely tight during depressions. Such loan practices have ordinarily resulted in accentuating losses

by the depreciation of both real-estate and chattel security. Another difficulty has obtained from the overvaluation of livestock in appraising the proper relationship of owned range or range privileges to chattel security as a satisfactory basis for credit. Maintenance of the range resource merits greater recognition as being of fundamental importance in credit stabilization and the determination of favorable loan-amortization rates. The evil of placing excessive-credit reliance on livestock security without proper consideration of the range resource has frequently reacted unfavorably to loan agencies, to stockmen, and to the range.

The loan-agency requirement that the range land upon which the chattel security is based be a fee-owned, self-sufficient unit, or that leases, permits, or privileges for grazing on other private or public lands be made a part of the collateral and that the lessors or permittors be bound to recognize transfer and assignments in case of foreclosure or other subsequent transactions is a credit situation which may adversely affect range maintenance. These privileges are thus virtually noncancelable and not subject to material reductions of grazing animals during the life of the loan. Consent to such pledging of Federal-grazing privileges on public lands, as security for private loans, cannot be effectively harmonized with range restoration and the requirements of other public resources, interests, and demands.

Under the Federal Farm Credit Acts, however, more favorable and satisfactory public credit facilities are rapidly being developed. These include discouragement of overexpansion, longer durations for loans, lower interest rates, adequate provision of range and other forage, careful inventory of forage as well as livestock and other assets, and recognition of the moral risk of the borrower.

The private land owner must accept his obligation to develop, maintain, and perpetuate the range resource as the collateral for dependable long-term credit. The wider use of cooperative associations, which guarantee the integrity of credits of their members, should help in lowering interest rates and strengthening individual credit ratings.

Public studies of long-time livestock values and returns are important in establishing interest rates, loan terms, and equitable long-term-loan retirement rates. A further investigation of the needs and methods of using long-term Federal credit might be of vital importance in providing working capital and in freeing operators from forced liquidations.

TAXATION

At present, in practically all of the western range States, it is impossible to ascertain the assessed values of range lands from tax records as they are usually involved in a classification with other property. Studies of the assessment of forest and other lands indicate an almost universal tendency to assess lands of low productivity at a relatively higher ratio to actual value than obtains with more productive land. Because of this tendency, low-value range lands are probably at a disadvantage (*47*).

The private owner, through his various associations, may appropriately exert his influence in favor of an adequate survey of prop-

erty-tax system in the range region. Any such survey should stress determination of existent assessment practices and basic data, which would be invaluable as a foundation for a more equitable assessment. Possibly the experiences of Wisconsin, where State supervision of assessment and equalization between taxing districts is more successfully conducted than in most States, afford a satisfactory solution (*47*).

In this study of taxation, range lands should be classified separately from farm lands and other properties, and the size of the tax burden in proportion to the values and the incomes from the various classes of property should be determined. This would indicate whether the range lands are actually taxed higher in relation to productivity than other classes of property. Since a large part of the property tax goes to support local government, it may also be desirable to include some analysis of the cost and organization of local government in districts where range land predominates in order to determine whether such cost may be reduced, or at least of decreasing the local expense burden, without curtailing essential functions. A reduction in the number of local governmental units and other measures which have been suggested (*47*) for relieving the burden of taxation in sparsely settled forest districts may generally prove equally adaptable to range-land areas.

RESEARCH AND EXTENSION

The scientific background on which future range management must be based is new and limited. Extension aid for the range problem is restricted to a few localities where county agents and extension livestock specialists give it scant and sporadic attention, incidentally to the assistance rendered arable-land agriculture. Stockmen are entitled to direct extension aid on their range-management problems. The program on research and extension, a public responsibility, is outlined in a succeeding part of this report.

Improving Rural Social and Economic Conditions

The fundamental purpose of any potential program should be the permanent betterment of rural social conditions by improving the basic economics of private ownership of western range lands. Considerable of the difficulty would be solved if the financial income of the individual producer could be assured at a point where he would be able to make his home a better place of abode, typical of a higher plane of living than most owners now can possibly even anticipate. Efficient and comprehensive development of such an objective may be the foundation stone of a new and more enduring livestock ranching industry. To adequately consummate such a program private owners and the public both have important responsibilities.

The private owner operating on submarginal lands or on a unit that is socially and economically unsound should recognize either the necessity for adjustments which will overcome unprofitable operations or the abandonment of the endeavor to make a satisfactory home under such adverse conditions. Those outfits remaining in private ownership should recognize that management principles which will rehabilitate depleted ranges and assure most effective use

of the forage and reasonable returns from the livestock, need to be instituted. Inflationary land values must be written off, the range resources maintained, and greater use made of cooperative effort in guaranteeing loans in order to stabilize land values and secure sound credit.

The public should make provision for gradually acquiring approximately 125 million acres of submarginal lands, especially those with high public values, in order to assure such management as will safeguard public interests. It should also facilitate the development of sound social and economic home units. This is especially true for ranches dependent upon public range lands for grazing as part of their economic security, or where the owner can be employed on work aimed at the betterment of public lands. Already the Federal Farm Credit Administration is furnishing credit facilities which are stabilizing range-land enterprises. Further extension of such credit facilities would be desirable. Adequate studies of taxation affecting range lands and ranch properties used in connection with range lands are needed in an effort to develop more equitable taxation.

The stockmen and livestock associations would perform a real service for rural life by fostering public interest and action in improving rural social conditions. No great material and permanent advance can be consummated in rural living, however, unless appreciation and pride in the land resource are accepted as the foundation stones of rural civilization. Economic distress, traceable to land abuse, cannot be ameliorated or removed until stewardship of the land becomes the tenet of rural thinking.

The quest for new lands to conquer must be replaced by the desire to improve and maintain the lands already occupied. Any conscious community effort to bring the ranch and the range into full productive capacity will be accompanied by innumerable social dividends and benefits.

THE MANAGEMENT OF RANGE LANDS

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The essential features of the program for the management of the western range lands are interwoven throughout the whole agricultural fabric of which it is an integral part. Dependent individuals, rural communities, and to a lesser extent the urban centers, have not enjoyed the social and economic security which sound development should bring. The rule-of-thumb methods, discussed previously, which have been used in handling range lands have resulted in excessive stocking and serious range depletion. If this condition is to be corrected, technically sound range management practices must be substituted. This is the premise upon which the proposed program is based.

Clearly, the forage crop should be so used as to maintain the highest state of productiveness and at the same time afford the greatest total contribution to the livestock industry and other legitimate services of the range. Numbers of livestock; availability of range for each season of use; the production of supplemental feeds such as hay, grain, agricultural byproducts, and irrigated pastures; and the requirements for wildlife, recreation and watershed services, and timber production on forest ranges, must be kept in balance if maximum production without misuse of the range is to be had.

The livestock contribution must, as nearly as possible, be predicated on sustained production. This means stocking of the ranges only to that point where—the possible use of supplemental feeds considered—excessive forced shipments will be unnecessary even during drought years. The apparent surplus of forage left on the range during good years will constitute a worth-while investment in soil and plant building, watershed health, and in feed reserves for the dry years.

The halting of unchecked damage and the rehabilitation of depleted ranges is the first step in the program. Overgrazed and run-down ranges on which the volume or quality of forage now produced has been seriously reduced through improper use must be brought into satisfactory condition. Generally this will simply mean lighter stocking and better management, but for some conditions a complete rest of the range for a few years will be necessary. In the worst instances of depletion by grazing, and on a large part of the land which has been plowed and abandoned for crop use, artificial reseeding will be required if something approaching maximum productivity is to be realized within a reasonable time.

Under such a program the best contribution that the range, all things considered, will make to social and economic well-being will

be through the maximum application of the multiple use principle. Pasture for domestic livestock, watershed protection, feed and cover for wildlife, recreational opportunities, and timber production where practicable are all legitimate services which range lands can supply. Except for limited areas, range land can contribute to each of these services without excluding the others. Conflicts between the desires of special groups often represented by organized vocal minorities will have to be met. The solution in each instance requires the type of coordination which results permanently in the greatest service to the most people.

More recognition should be given to the extent to which depleted ranges counterbalance improvement made by livestock breeding. As shown in discussing the functions of an integrated agriculture for the West, the increased values which good breeding should insure to the stockman are too often lost because of the low plane of nutrition furnished by overgrazed or depleted ranges. Light-weight feeder steers and half-fat lambs, instead of grass-fat steers and "top" lambs, are dumped on glutted markets. Calf and lamb crops are reduced materially. But the most serious repercussion of overstocked and depleted ranges on animal husbandy comes during drought years, when breeding herds built up at great expense over a period of years too often must be sacrificed. Thus the profits expected from improved animal-husbandry practices are reduced if not entirely lost.

Lack of certainty in predicting future requirements for agricultural products is a national problem. The future balance between export demands and import needs, and even the possible volume of domestic consumption are baffling questions to which the best thought of the Nation is being directed. The estimate that more than 25 million acres of now submarginal cropland, not yet abandoned, must be diverted to other use is based in part on the threat of periodic overproduction. That most of this land must revert to pasturage is obvious. Thus new concepts in range stocking, in providing for wildlife, in improving watershed conditions, and in recognition of recreational needs are being worked out.

Conversely the range may serve as the reservoir of land from which to draw additional acreage for crop agriculture if needed. Reclamation through irrigation as a part of the resettlement program, for example, seems logical and will remove some of the more fertile level land from range use. Emergencies, such as those which arose during the World War may arise again and require temporary major increases in crop acreage and in livestock production. Such demands will be met more easily if the natural range lands are rehabilitated to maximum productivity and the soil on areas now submarginal for crop use is improved and protected from erosion by providing a satisfactory plant cover. Thus the range may well be one buffer against contingencies which arise from changing land-use requirements.

Although the program best suited to meet the needs of the West should be built around the multiple-use principle, for simplicity of presentation each of the five major functions of livestock production, watershed protection, wildlife, recreation, and timber production will be discussed separately.

A Program for Domestic Livestock Production

Three systems of grazing have been recognized as desirable to restore and maintain the plant cover. As described below, the conditions which must be met will decide which system is best for a given area.

SYSTEMS OF GRAZING

Deferred and rotation grazing (*11*)* reduced to its simplest form means dividing the range into from three to five units and deferring grazing on one unit each year until after the seed crop has matured. By so treating a new unit each year the entire area will be rested and grazed in rotation.

The system, developed on mountain ranges, is primarily applicable to stands of perennial grasses that are chiefly dependent upon seed for their perpetuation. Other systems of conservative management may be better adapted to certain types of short-lived annual forage plants which dry quickly and are less palatable after maturity, or to certain perennials that reproduce by runners or "stooling" instead of seed.

Experience has shown that most forage plants can, after seed maturity, withstand the removal of as much foliage as is ever desirable from the standpoint of good range management. As a guide to intensity of this deferred use, 20 to 30 percent of the palatable growth of the important forage plants should be left when the stock are finally removed for the year.

The deferred and rotation system is especially adapted to use on sheep range. The close control under which the band is held makes the system usable without the cost of fencing. With cattle or horses its use becomes complicated, in many cases requiring, in addition to salting and herding control, the construction of drift fences or pastures if the stock are to be held off from deferred areas. With ample range for each season, however, the objective should be to so handle most range areas to which the system is adapted.

In application, the number of divisions of the range is based on the period of grazing left after seed maturity. For example, if one-fifth of the season remains after seed maturity, the range may be divided into five parts and each year one of the five divisions is in turn left ungrazed until toward the end of the season. After the seed has ripened, the stock are moved to the area and in grazing over it help to scatter the seeds and cover them with soil.

In order to protect the new seedlings which germinate the following spring, the area deferred 1 year should be grazed next to the last the following year. The objective, of course, is to secure an ample seed crop, help seedlings to become established, and provide protection until they become a part of the native plant cover.

Continual moderate grazing is more suitable than deferred and rotation on (1) ranges used yearlong, such as those of the Southwest; (2) on many cattle ranges where it is not now feasible to construct the fences and structures required to control the movement of the stock; (3) for those important forage species that are

* Because of space limitations the treatment of technical features of range management must here be kept brief and simple. The references cited throughout this section cover the topics in detail and cite additional literature on the specific subjects.

not dependent on seed for reproduction; and (4) locally in Arizona, the Northern Great Plains, and California where certain areas are used during the winter and others during the summer. Where this system is used the number of stock grazed must be small enough to permit about one-fourth of the seed from the better forage plants to ripen. It is very desirable to so handle the stock that each year a portion of the range is used very lightly, since rest periods for the range and a chance to build up plant vitality are essential. This system requires frequent and careful inspection to make sure that the better forage species are not progressively being eliminated.

Alternate grazing is limited to ranges where it is possible to use a tract for a few weeks, after which all of the stock are removed to another area and kept there until the forage on the one first grazed has made enough growth to withstand another period of use. This system is highly effective on cultivated pastures under irrigation or in humid regions where heavy grazing for short periods helps to keep the coarse plants in check. On arid ranges, however, the heavy use for even a short period is likely to damage the soil, encourage erosion, and destroy part of the plants by trampling. Obviously this system can be applied much less generally than deferred and rotation grazing or continual moderate use.

RANGE REHABILITATION

Most of the 721 million acres of usable range land can be restored to full productivity during use if the numbers of livestock grazed and the systems of management provide fully for natural revegetation and protection of the plants after establishment. On possibly 340 million acres of these lands, though there has been loss of fertility, there is enough topsoil rich in organic matter and with sufficient water-holding power to insure forage recovery if the intensity of grazing and period of use are corrected. All that the plants require under these conditions is a chance to grow green leaves, to retain them long enough to produce sufficient plant foods, and to bring about food storage in the plant roots and stems. Plants so protected are vigorous and either by seeding or otherwise will reproduce satisfactorily. An opportunity for existing plants to retain their vitality and reproduce is absolutely necessary if ranges are to be restored and maintained.

Unfortunately, well over 100 million acres of range lands has been so badly abused by grazing that most or all of the fertile topsoil is gone, on which conditions of both nutrition and moisture are unfavorable for plant growth. On such soils, even under moderate grazing, natural revegetation is slow. No great increase in vigor of old plants can be expected until the soil is built up. Several plant generations of weeds, annual grasses, and other plants capable of growing on poor soils of low water-holding capacity will be required. Complete closure to grazing, and other special treatment, including artificial reseeding, may be necessary.

Artificial revegetation is necessary on nearly 88 million acres of range land from which the desirable forage species have been largely removed. Two types of land are involved: (1) those areas from which all of the desirable forage has been eliminated by plowing for crop agriculture, and (2) those on which continued grazing abuse

has depleted the vegetative cover, and in some instances the soil, to a point where natural revegetation satisfactory for grazing or watershed protection will be entirely too slow of accomplishment. Studies in Montana, Colorado, and Utah, discussed elsewhere, show that for the first type of land it will take 20 to 50 years to restore the native cover.

On good soils, either abandoned plowed or denuded range land, perennial grasses and the most valuable herbs and shrubs may be seeded at once. The abandoned dry farms that make up the larger part of this class of land originally produced fine crops of native grasses. Normally, the soil is still good enough to justify prompt reseeding with the best plants available. No attempt is here made to name the species best suited to given regions as conditions vary so greatly that final choice must be based on the characteristics of the site and locality to be planted. The State agricultural colleges and the Forest Service can furnish advice based on experience. On these better areas reseeding is a relatively simple problem. However, the likelihood of drought makes it unsafe to predict success more than half of the time, and therefore, in estimating costs for large areas it is safe to assume that two seedings will on the average be needed.

On eroded soils which lack the proper plant foods, the problem is far from simple, as the sowing of perennial grasses and other of the most valuable forages offers little hope of success. Only those plant species that can withstand raw soils and irregular moisture supply can succeed. In order to restore this class of range a detailed study of soil condition and also of the plants that will survive must be made. Native weeds and legumes and imported species must be tried and provision must be made to collect or produce seed in ample quantities from those that are successful. Plant breeding to develop desirable strains suited to badly depleted soils is urgently needed. For certain species the planting of pieces of sod or rootstocks is more logical than propagation by seed. Also in many instances cheapest and most satisfactory results will be had by revegetating numerous small spots or key areas from which a cover will spread to or fill in the space between.

On abandoned crop land and other level denuded areas the common grain drill with a part of the holes plugged is very effective. Usually, even in the case of heavy stands of Russian thistle or other weeds, it is best to drill on land not prepared by plowing or harrowing. If the weeds interfere seriously with the operation of the drill they may be burned broadcast or in windrows. Seeding on unprepared ground not only reduces the cost but in many instances will increase the percentage survival.

Great areas of rough, steep, and brush-covered ranges cannot be drilled. Under such conditions the seed must be scattered by hand and trampled in with livestock or by other inexpensive methods. A few areas not suitable for drilling, but with good soils and in key locations, ought to be seeded on furrow edges plowed at intervals and covered with a brush drag. The labor costs by this method are high, but its use on key areas having deep productive soils makes success likely.

Whatever the method of reseeding and whatever the plant species reseeded, complete protection from grazing for one or two seasons is required in order to permit the seedlings to establish themselves.

Very often it may be desirable to supplement by artificial reseeding the natural reseeding provided for on that part of the range to be improved by deferred and rotation grazing, or by continual moderate grazing. In such case the expense and trouble of reseeding require that proper intensity of stocking and proper grazing management be provided in order to prevent failure.

Cost figures for the various methods of artificial reseeding for range use are not too reliable, but using the methods described they should be low. The most serious problem is that of securing a sufficient supply of suitable seed. Assuming that an ample seed source will be developed as needed, and that a market price of around 15 cents per pound may be expected, the cost, using a grain drill and 4 to 5 pounds of seed per acre and figuring on failure half the time, should not exceed $2.50 to $3 per acre. With hand seeding and trampling in by livestock, the cost for two seedings should not exceed $1.50 to $2.50 per acre. Final decision as to the necessity and feasibility for planting any area must, of course, be based on careful consideration of conditions on the ground. Detailed surveys required to select areas are in most cases lacking; therefore the data given in table 80, which gives an estimate of acres and costs, by ownerships, are only indicative of the size of the job ahead.

TABLE 80.—*The extent of the indicated artificial range-revegetation program and costs, by ownerships*

Ownership classes	Area (acres)	Cost per acre	Total cost
National forest	780,000	$2.20	$2,730,000
Indian lands	1,630,000	2.65	4,645,000
Public domain, grazing districts, etc	18,000,000	2.55	45,900,000
State and county	2,460,000	3.05	7,505,000
Private	15,010,000	2.20	33,022,000
Total	37,910,000	2.67	103,902,000

PESTS, DISEASES, AND POISONOUS-PLANT ERADICATION

Poisonous plants are a menace to the success of range revegetation or utilization. Most poisonous plants occur in great abundance only on ranges so badly depleted that the more valuable forage species are weakened or killed. In the more open spaces, on soil too poor in organic matter to support the better forage grasses, weeds come in. Some of them, like low larkspur, loco, lupine, deathcamas, sneezeweed, and horsebrush, are poisonous. They tend to increase on noneroded soils on which heavy or untimely grazing removes the valuable forages. Some species like tall larkspur, waterhemlock, and sleepy grass may grow on good ranges with good soils. The real remedy for most poisonous plants is to remove the causes, i. e., to bring about by conservative use, and reseeding when required, the revegetation of the range by the more valuable forages. On a few key areas, especially where tall larkspur or waterhemlock occurs, grubbing or treating with chemicals may be practiced at costs of about $8.50 an acre for grubbing or $6 for treating with chemicals. Even when these practices are resorted to it may be necessary to revegetate the range with good forage, lest the poisonous plants again occupy the area.

Rodents are a menace on about 285 million acres of range and must be checked by the use of poison bait, trapping, or by other accepted methods of treatment. The cost will be about 8 cents per acre. A reasonable 10-year program should doubtless plan on control measures on approximately 150 million acres, at a total cost of about $12,000,000.

Although native plants are not seriously injured by disease, it is possible that species developed for artificial reseeding may be. Close watch must be maintained to insure the use of disease-resistant species for range restoration. Some undesirable plants, such as "cheat grass", are subject to smut and may be thus held in check. However, it is much surer and much safer to accomplish the same thing by favoring desirable species through range management and reseeding. In the absence of fire or too severe cropping, the better native species will suppress such undesirables and succeed them in occupying the range.

GRAZING CAPACITY

The range should be stocked with the number of animals which the unit will support each season over a period of years without injury to the range, tree growth, or watershed, or unwarranted interference with game and recreation (*79*). Figure 85 graphically indicates present grazing capacity of western ranges. Since the various species of plants differ greatly in palatability, it is to be expected that the better kinds will be most heavily grazed. In determining grazing capacity the degree of use of the most palatable of the more abundant species must control. On ranges where the desirable plant species have been seriously reduced in number, stocking should be such as to encourage their return to importance. Thus, on properly stocked ranges the least palatable plants will barely be nibbled.

When a range is stocked more heavily than its true grazing capacity, either (1) the cover will get thinner, thereby exposing bare ground; or (2) the tough, woody, gummy, or unpalatable plants will increase in relative or absolute abundance. Rangers and stockmen should note carefully which plants are not eaten by livestock and check on their increase from year to year as an indication of overstocking. Experience has shown that somewhere near 20 to 30 percent of the palatable growth of the more important forage species should be left ungrazed each year. An adequate series of permanent plots from which detailed annual records of plant numbers and conditions can be kept is essential to really reliable and accurate determination of the proper degree of stocking. Also, on areas covered by range surveys, forage-acre figures arrived at by the method developed on national-forest ranges [49] will be found especially helpful.

Additional considerations in making grazing capacity estimates include, among others: (1) History of grazing use of areas; (2) fluctuations in forage crop from year to year, due chiefly to climate, as previously explained; (3) deductions (on depleted ranges) to provide a safety margin for their improvement; and (4) necessary allowances for unfavorable physical conditions, such as rough to-

[49] U. S. Department of Agriculture, Forest Service. Instructions for grazing surveys on national forests. 40 pp. 1925. [Mimeographed.]

pography, young timber growth, inadequate livestock watering places, or poisonous plants.

That range lands in all types and in all ownerships have been too heavily grazed has been fully discussed in a preceding chapter. As a result, drastic action will be required to restore this empire of range lands to something approaching maximum production. Table 81 shows by the major types the original and present grazing capacity of the land now in range and the percent to which each type has been depleted through improper management. In only the tall-grass type is depletion less than 25 percent and in only one other (open forest) is it much less than half. Since depletion is continuing on most of the range area, the task of restoring these ranges will require material reductions in the number of livestock now using the range. Table 82, which is based on the best information available, shows that an average reduction in animal-months' use of 38.5 percent will be required to bring the stocking down to a

TABLE 81.—*Grazing capacity of western ranges, by types*

Types	Virgin range, grazing capacity		Present range		
			Grazing capacity		
	Acres per animal-month	Animal-months per section	Depletion (percent)	Acres per animal-month	Animal-months per section
Tall grass	1.9	337	21	2.4	267
Short grass	2.1	306	40	4.1	150
Pinyon-juniper-grass	2.3	261	51	4.8	142
Semidesert grass	2.9	221	58	6.4	100
Southwest grass	2.9	221	67	8.6	72
Southern desert shrub	4.4	146	63	11.5	56
Salt-desert shrub	5.7	128	71	17.9	36
Pinon-juniper	3.4	188	63	9.4	70
Woodland-chaparral	4.9	151	70	8.5	62
Open forest	4.0	169	28	5.9	159
Average	2.7	227	52	5.7	113

TABLE 82.—*Present stocking, present grazing capacity, and potential grazing capacity (50 years hence) on the western range area*[1]

Ownership classes	Present stocking, animal-months per section	Present grazing capacity, animal-months per section	Reduction required to reach grazing capacity		Potential grazing capacity, animal-months per section	Change from present stocking		Increase over present grazing capacity	
			Animal-months per section	Percent		Animal-months per section	Percent	Animal-months per section	Percent
National forests	96	89	6	6.3	100	+11	+11.5	17	19.1
Indian lands	105	76	29	38.4	120	+14	+13.3	43	56.6
Public domain, grazing districts, etc.	94	53	41	43.6	94	.....	.....	41	77.4
State and county	230	113	117	50.9	195	−35	−14.9	82	72.5
Private	230	140	90	39.9	227	−3	−1.3	87	62.3
Average	102	112	70	38.5	100	2	1.1	60	53.7

[1] Ultimate stocking is based on the formula $\frac{(100-D)\,P}{\%\,V}$, in which D is the percent of depletion, P the animal-months per section of present range, and V animal-months per section of virgin range. Virgin carrying capacity is assigned by percents varying from 70 for public domain lands (all Federal grazing districts and Indian lands) to 85 for national forests, to account for some encroachment of timber reproduction, retarded improvement under continual grazing use, and especially limitations in recovery due to depleted soil. Credit is given for increased carrying capacity due to anticipated artificial reseeding. The results of the formula were modified slightly where justified by more accurate data.

point where the ranges can recover. It is significant that this reduction from present stocking varies from only 6.3 percent on national forests, where the ranges have been carefully handled for many years, to 50 percent on State and county lands, where, as a

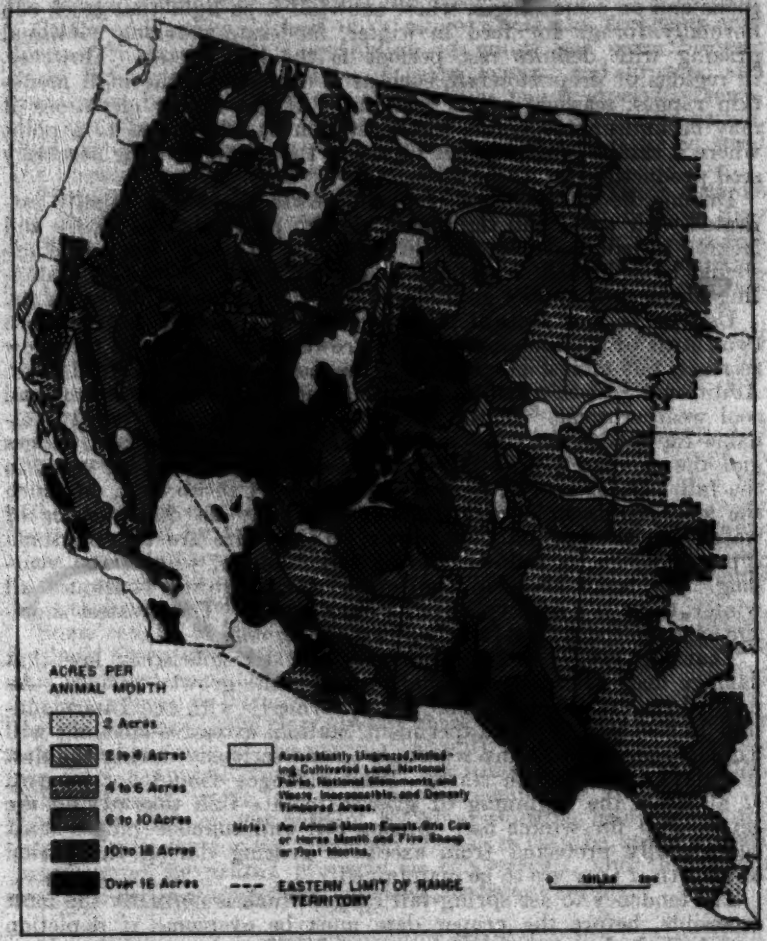
ACRES PER ANIMAL MONTH
2 Acres
2 to 4 Acres
4 to 6 Acres
6 to 10 Acres
10 to 16 Acres
Over 16 Acres
Areas Mostly Ungrazed, including Cultivated Land, National Parks, National Monuments, and Many Inaccessible and Densely Timbered Areas.
Note: An Animal Month Equals One Cow or Horse Month and Five Sheep or Goat Months.
EASTERN LIMIT OF RANGE TERRITORY

FIGURE 85.—PRESENT GRAZING CAPACITY OF WESTERN RANGE LANDS.

The tall-grass type of the prairies, which has the smallest average depletion, also has the highest grazing capacity, an average of 2.4 acres per animal per month. The short-grass and Pacific-bunchgrass ranges, although depleted one-half, also have a relatively high capacity. The salt-desert shrub type of the Intermountain Region which is depleted most severely, averages 17.8 acres per animal per month. (See figs. 25 and 30.)

result of accessibility and lack of management, use has been heaviest. Perhaps the most significant required reduction is the 43.6 percent for the grazing districts, unreserved public domain, and "other Federal" reservations, because it applies to an extremely large acreage.

PROPER SEASON OF USE

Use of the range only during the proper season is equally as important as not exceeding grazing capacity (*79*). In some regions and on some ranges, where snowfall is so light that stock can normally forage for feed in winter, moderate yearlong continual grazing with definite rest periods is the best system. However, in regions of deep snowfall, such as is common on the high mountain ranges, seasonal use is essential. At the higher elevations it may be midsummer before the vegetation has developed to a point where it can be eaten without injury to the plants or their necessary seed production.

During the early period of plant growth the soil is usually saturated with water and the plants, though palatable, are washy and lacking in balanced nourishment for stock. During this period use should be lightened or stopped to prevent great damage by trampling of the soft, muddy ground and also the pulling of many plants.

Usually in the foothill zone and valley edges of the northern two-thirds of the mountain region growth begins early as the snow retreats, but almost stops during the hot weather of midsummer. Additional growth often takes place again when the fall storms and cool weather come. In the spring such ranges are extremely valuable for use by stock moving between feed yards or winter ranges and the summer ranges in the high mountains, and vice versa in the fall. Other ranges, such as the salt-desert shrub type, on which the snowfall is light and there is ordinarily no other source of water, can be used only in winter. Thus there are four seasonal types of range, as follows: Spring-fall, summer, winter, and yearlong. On large areas in California where growth continues all winter, there is a fifth type, fall-winter-spring. The greatest shortage exists in the spring-fall class in most regions.

Yearlong ranges should always be stocked sufficiently low that damage does not occur, especially during the growth periods. As pointed out by Dr. E. C. McCarthy, formerly with the Intermountain Forest and Range Experiment Station, excessive stocking will damage the plants at any season, but most seriously during the first few days after growth starts. Winter ranges should not be used at all from the beginning of growth to late fall, thus saving the entire crop for winter use. Spring-fall and summer ranges must be carefully protected from excessive grazing during the period of growth if they are to be maintained.

The tendency to use spring-fall range, which is normally the most accessible, before the proper date must be overcome if depletion is to be halted and the ranges improved. Here is one of the places where the closest kind of coordination is required to balance the use of the resources of ranch and range. One possible relief is in the increased use of farm pastures and of supplemental feeds, both roughages and concentrates, including the expanding list of agricultural byproducts. Another possibility in certain regions is in the possible diversion of either winter or summer range to this season of use with extreme care in stocking and in management. It is certain that the problem will not be solved by abuse of the limited area of spring-fall range available. Such treatment can only aggravate the situation.

CLASS OF STOCK

Each unit of range is ordinarily best suited to use by only one class of stock (*79*). The factors which control are the character of the forage, distribution of water, and topography.

Cattle and horses do best on a range where the forage is predominately grass with a sprinkling of weeds and some browse; sheep like nearly equal parts of grass, weeds, and browse, and goats more browse. However, this balance is not especially sensitive and the presence of ample forage is the main consideration. Sheep or goats do well on straight grass ranges, and cattle on weed and browse, or sheep on browse and grass.

Frequently other factors than the suitability of the range controls the class of stock to be grazed. The local livestock industry may be built around the class of stock for which the range is not best suited. In such instances the important feature is that stocking be based on the feed that the class of stock grazed can be expected to use under good management.

Cattle must have access to water daily during hot weather but sheep can go 2 to 5 days (much longer during cool weather), depending on the succulence of the forage and the amount of dew, and can reach out farther from watering places.

Steep, high, broken ranges are more readily used by sheep, and low brushy ranges by cattle. Goats are capable of using forage on rougher, more brushy, and hotter localities than are suitable for either sheep or cattle. When one class of animals is using a range better adapted by feed, topography, elevation, or water to another class, extreme care must be taken not to overstock. Only the feed within reach and usable by the class of stock on the range should be considered in determining grazing capacity.

Some ranges, at least theoretically, will contribute most if grazed by both sheep and cattle, and some by goats as well. In practice this so-called common use has not been widely successful because of the tendency to introduce the second class of stock without reducing the numbers of the class already there to maintain sufficiently the total stocking rate at the grazing capacity of the range. Common use, thus, has usuall ymeant double use which is fatal to the range. Where forage, water, and topographic conditions are such as to permit of common use without the total stocking being above the grazing capacity for the combined classes, it may be used. Future ranges must be grazed properly in this respect, and this means scientific range management based on the forage supply.

DISTRIBUTION OF STOCK

Next to the proper rate of stocking, distribution of the stock on the range is the most important feature in range management (*79*). Any improvement in the distribution of animals is reflected in more even utilization of the forage. Overuse of small areas, especially on cattle ranges, cannot be prevented entirely, since the animals naturally congregate at watering places, at bed grounds, and along routes of travel. All of these conditions are much improved through (1) avoidance of heavy stocking, (2) providing water at short intervals,

(3) the use of sufficient, well-located drift fences, and (4) proper attention to salting and herding.

Water development (*15, 139*) aids distribution but on many ranges involves heavy expenses for deep wells, for pumping, for the construction of reservoirs, and for the development of springs. For cattle the ideal arrangement is to so locate the watering places that the animals can graze out to the boundary of the area served in half a day—perhaps a mile on gently rolling country, and less where the topography is rough or broken. The high cost, however, usually forces a compromise between travel for the stock and cash outlay for the improvements. On gently sloping ranges, cattle can travel 2½ to 3 miles to water, but on steep slopes and rough topography 1 mile travel is probably as much as should be required. Sheep can travel roughly twice as far to water as cattle. Table 83 indicates the approximate size of the water development job on range lands in various ownerships.

Properly located drift fences (*79*) are often essential to good distribution of cattle. Not only do they help to force the use of less attractive ranges but also they are necessary in any attempt at proper seasonal use. Range cattle, particularly, have a tendency to follow the snow line back in the spring and can be successfully held back until the forage is ready for use only by a series of well-constructed and properly located fences. The best estimates obtainable indicate that the investment shown in table 84 will be required to fence properly range land in the different ownership classes.

TABLE 83.—*Range-water development program, by ownership classes*

Ownership classes	Number of projects	Costs	
		Per acre of range	Total
National forests	6,300	$0.0497	$1,362,000
Indian lands	2,000	.0510	1,500,000
Public domain—grazing districts, etc.	4,000	.0300	3,000,000
State and county	2,700	.0122	600,000
Private	16,900	.0300	[1] 5,310,000
Total	31,615	.0185	11,770,000

[1] Cost estimates for the private-land program are made on the same basis as for public land. Actually a very large part of the work, if done, will be as a short-time job. The cash outlay thus will be very much smaller than this figure.

TABLE 84.—*Range-fencing program, by ownership classes*

Ownership classes	Miles to build	Costs		
		Per mile	Per acre of range	Total
National forests	13,200	$320	$0.0202	$4,224,000
Indian lands	7,000	300	.0210	1,500,000
Public domain—grazing districts, etc.	14,000	300	.0150	4,200,000
State and county	11,000	300	.0405	3,300,000
Private	16,000	312	.0312	[1] 4,944,000
Total	61,000	307	.279	18,168,000

[1] See footnote to table 83.

An ample supply of very coarse or block salt (*38*), properly distributed both as to location and as to time of use is required for equal utilization on cattle ranges. Salt grounds, particularly on poorly watered ranges, should be so placed in strategic locations away from water as to induce the use of the maximum areas of the range. The stock naturally tend to work from water to salt and vice versa, grazing en route. Obviously, a carefully planned distribution of salt grounds which considers not only the area of range to be used but also the proper time of use is a major feature in distribution. Salting is an integral part of the current operating expense and therefore no estimate of costs is included.

Herding of sheep is an old practice but needs to be done intelligently to bring about proper use of the range. "Open" rather than "close" herding, minimum use of dogs, and one night use of bed grounds are all practices which ought to be standard. Such handling not only prevents localized overgrazing and excessive trampling but also produces fatter sheep on the same amount of forage. Education, regulation, and inspection are the only costs of this step.

Herding naturally is less effective with cattle than with sheep. Cattle do not normally graze in bands and there are fewer stock to a given unit of area. Owners of large numbers of stock and associations using a range unit cooperatively should provide riders who can rather effectively direct the stock to the range which would otherwise be underused. Usually salting is a part of the function of the herder or rider. Here again the cost is an integral part of the current operation.

NEED FOR MANAGEMENT PLANS

The full use of range lands without damage by domestic livestock is dependent on continuity in applying a fundamentally sound plan. A plan followed one year and abandoned the next serves no purpose. Without this, use becomes haphazard and the evils described earlier as accompanying rule-of-thumb management are bound to result.

To be of value the plan must be simple and workable and preferably should be recorded on suitable maps. It should take into account such essential features as (1) the grazing system, (2) grazing capacity, (3) season of use, (4) distribution of stock, (5) the need for special rehabilitation measures, and (6) any special provisions needed for watershed protection, wildlife, or recreational use. For areas of any size the plan should be a written record and should be revised each year if necessary to meet changing conditions.

Unfortunately, the preparation of a thoroughly sound plan is not a simple matter. Knowledge is needed of the requirements and habits of livestock as well as of the requirements and habits of various plants. For this reason, and because professional services in this field are not otherwise available, this is a most promising field for public aid. Through extension services and with the active cooperation of the owner, plans based on available research and any necessary surveys and study of the property should be offered to private owners. The more progressive stockmen would welcome assistance in this field.

The estimates of acres and costs shown in table 85 are based on the assumption that thoroughly sound plans should be prepared for

all range land regardless of ownership. The necessary range surveys are included in the estimates because the survey and plan are almost inseparable. Costs per acre vary from 1 mill per acre for areas where productivity is low and other public values are small to 1 cent per acre where special problems of multiple use are involved. As a result the cost per acre for range surveys and plans varies by ownership from about 5 mills per acre on private land to 9 mills on the national forests.

TABLE 85.—*Area and cost of range surveys and management plans, by ownership classes*

Ownership classes	Area (acres)	Cost	
		Total	Per acre
National forests	26,000,000	$312,000	$0.0090
Indian lands	26,000,000	216,000	.0074
Public domain—grazing districts, etc.	140,000,000	605,000	.0043
State and county	66,000,000	241,000	.0036
Private	215,400,000	800,000	.0040
Total	513,176,360	2,000,000	.0090

POTENTIAL CONTRIBUTION FROM THE RANGE

The range resource has contributed enormously to the development of the West, but unfortunately in making that contribution the resource itself has been damaged to a serious extent. Range lands in most ownerships have been depleted by overgrazing, improper seasonal use, and other mismanagement. Over 50 million acres, which proved to be submarginal for such use, was plowed up in an attempt to grow wheat and other dry-land crops. The aftermath of the development period thus imposes a serious task of rehabilitation and restoration if this once great resource is to be built back up to a stage of productivity equal to that which existed under virgin conditions. That this will be a slow process on ranges from which the better kinds of plants have been removed or from which much, if not all, of the top soil has been lost is recognized. On the other hand, it is probable that by using such species as crested wheatgrass in reseeding abandoned dry farm lands the production will exceed that of the original native forage.

Not only is the restoration of the ranges required for maximum sustained livestock production, but also the function of vegetation in controlling erosion and improving water flows makes such treatment even more important. Thus the range, through livestock, furnishes a good market for the crops grown on irrigated ranches and also, if properly used, safeguards the continued satisfactory supplies of water of good quality for growing these crops.

Wildlife and recreation, two other major services of the range are almost inseparable. That neither can be developed satisfactorily under the present depleted condition of most of our ranges is perfectly clear. There is little food for game and less inspiration for people to be had from denuded or tramped-out ranges and eroded slopes and valleys.

Present excessive stocking on part of the forest range interferes with production of timber and other forest products. The tender shoots of young forest growth are grazed in the spring and needles are eaten in the late fall and winter when livestock remain on the range too long and snows cover the forage.

The extent to which the other major services will require closure for range use or reductions in numbers of stock grazed is discussed in another section. With these factors in mind and with full appreciation of the lack of a thoroughly reliable factual basis, the data on grazing capacity 50 years hence in table 82 are presented. Although a present reduction of 38.5 percent appears to be necessary if the ranges are to be restored, it is probable that at some future time the land will furnish the feed for as many livestock as are now using it to excess. To reach this objective will require full application of all of the principles of good range management. Attainment will fall short to the extent that management falls short of this ideal. In the final analysis it is not so important whether the present grazing capacity is increased by 60.7 percent by 1985 or whether it is some higher or lower figure. The important feature is the restoration of our ranges for the maximum contribution of the major uses to the welfare of the people of the West and the Nation.

A Program for Watershed Protection

Any program of management for range lands must provide adequately for the conservation of the soil and other protection of the watersheds. In view of their present condition, several methods of treating these lands will be required. Limited areas will need to be closed permanently to all grazing; small critical areas may need artificial erosion control; in some instances temporary closure to all grazing will be necessary; over a considerabe area of depleted ranges, utilization of forage more conservative than normal for range forage maintenance alone will be required; but, for the most part, the need will be answered by conservative range-management practices sufficient to bring about maximum continuous production of forage. Where vegetative depletion is not excessive and the soil resource not seriously impaired, the latter practice will ordinarily build up a productive soil mantle adequately protected from erosion and capable of absorbing maximum quantities of precipitation. In managing watershed lands in this manner, however, continual critical observations must be made to ascertain any evidence of incipient erosion on areas not now eroding and the rapidity of soil stabilization on eroding areas.

Restoration during grazing use usually sufficient

That the vegetative cover of the range can be restored at the same time it is being used for grazing has been demonstrated on the national forests, some privately owned land, and by research. On probably 90 percent or more of the total range area the watershed values including soil building can be conserved at the same time grazing is in progress. The one dominant theme is restoration of plant cover.

Although this usually can be accomplished by inaugurating the grazing practices previously described on badly deteriorated areas in order to shorten the period of restoration, utilization of the forage may necessarily be somewhat more conservative than would be required merely to restore grazing capacity. The inherent differences in topography and soil and the nature of the depletion and erosion over the range country will require a varied program of treatment.

On some areas of high watershed value or from which an intolerable amount of silt is coming as a result of past misuse, temporary closure to grazing is desirable. Even though the condition might ultimately be corrected during use, the element of time is extremely important. The damage likely to result even with limited use, so far exceeds the small returns from grazing on such areas that common sense dictates temporary closure. Once the plant cover is restored, these areas can again be used safely for grazing if properly managed. Careful and continued observation of such land is, however, essential to determine when these measures should be applied and when grazing can be resumed. For these reasons no attempt is made to estimate the area requiring such treatment and length of time such closure should continue. Application of a comprehensive program demands, however, that this method be used wherever needed and for such periods as may be necessary.

In some instances the municipal, agricultural, or industrial dependency on the volume or quality of water yield is so great that no impairment of watershed values can be risked and withdrawal from grazing use must be complete and permanent. Watersheds supplying domestic needs of Portland, Salt Lake City, and Pocatello are illustrative of desirable withdrawals for cities of different sizes. Some steep mountain areas with loose erosive soils, such as certain disintegrated granite slopes of central Idaho and similar areas in California, and considerable areas of vegetation types highly susceptible of erosion, must be closed for protection of investments in water-storage structures. Some areas of the arid Southwest, if they are to be protected from the erosion caused by heavy summer rains, must be restricted in use to a degree that would not be economical. Complete and permanent closure, as shown in a previous section, is recommended for 11½ million acres, or only 1.6 percent of the range area, in such exceptional situations.

ARTIFICIAL EROSION CONTROL NEEDED IN SOME CASES

On some watersheds where erosion is accelerating so rapidly that natural plant growth and reproduction cannot unaided combat and gain dominance over the forces of soil removal, artificial methods of erosion control are required. These methods include artificial revegetation as already described elsewhere, of denuded areas and supplemental structural undertakings such as terrace trenching and erosion-control dams.

Terrace trenching is a system devised to break up and halt sheet and gully erosion on slopes by retarding and controlling run-off until the vegetation can again control the situation. By a series of modified terraces built on slope contours, run-off is held until it can seep into the soil. An outstanding example of its application is on

the Davis County watersheds in Utah where 1,000 acres were treated at a cost of $41 per acre. It was only necessary to apply these methods on the denuded portions of this 16,000-acre area in order to halt erosion and check floods. This type of control has only reached the field experiment stage and therefore the cost may be reduced considerably. Obviously, however, the cost of such treatment will restrict its use to key areas on the most critical watersheds.

Erosion-control dams are used largely to control run-off in newly formed small channels and arroyos (gullies), of gentle or moderate gradient, and prevent their enlargement. In this method rough dams are built at intervals along the watercourse in such a way as to block rushes of water that have tremendous erosive force. Such erosion control has been used a great deal in the Southwest, in gullied mountain meadows in California, and elsewhere; but size and numbers of dams vary so greatly that it is meaningless to attempt average cost per acre figures. Considerable work of this type in the Wenatchee River Valley in Washington cost approximately $20 per acre and similar work on the Plumas National Forest in California necessitated expenditures of $25 per acre.

"Debris dams", with catchment basins above, have proved effective for trapping debris and reducing flood damage in established channels of watersheds in the Los Angeles region. Heavy erosion and run-off may occur locally on these exceedingly steep slopes, even when closed to grazing, if hard rains fall on areas freshly denuded by fire.

Water-spreading by diversion is also used in the Southwest, and in several other localities, as a means of erosion control. By this method dams or dikes are thrown up to divert water over flats where it is absorbed by the soil mantle. Cost per acre for this type of work in the southwestern region was approximately $2.50 to $3 per acre.

Artificial control measures on range lands obviously are rarely justified because of the expense involved, and they should be undertaken only where values to be protected are high and a definite need is demonstrated. In any event structural measures are only temporary, short-lived expedients to aid in stabilizing the soil while a cover of vegetation is becoming established. Coincident with any construction of trench terraces, erosion-control dams, or debris dams, restoration of the plant cover must begin.

RESPONSIBILITY FOR WATERSHED PROTECTION

The service which flows from properly managed watershed lands has both private and public aspects. At the one extreme is the large interstate watershed, supplying water for power, irrigation, and domestic use for industries, rural communities, and urban populations often at great distances from the headwaters. At the other extreme is the local mountain rancher who secures the same service from some small creek running through his property. Thus the obligation to protect the watersheds is a joint responsibility even though the major part must of necessity be borne by the public.

Private owners of watershed lands have an obligation to protect the watershed function. The responsibility of ownership carries with it the clear restriction that its use must not seriously damage your neighbor or the public. Thus the private owner of land does

have an obligation to so handle it that watershed values are not seriously impaired. As has already been shown for most of the area those range-management practices which will perpetuate the plant cover are all that is required. This sort of treatment is in the interest of the owner even though watershed values are ignored. Viewed realistically, critical erosion and high water yield areas should pass to public ownership to avoid the risks of misuse and damage to high public values. As shown in the earlier discussion of probable future use and ownership, such a program may involve 118 million acres now in private hands.

Municipalities dependent for their water supply on comparatively small nearby watersheds can efficiently manage and should own these areas if they are not already under the supervision of other competent public agencies.

States can and should manage their range lands in such a way as to conserve watershed values. Clearly, the responsibility of ownership carries with it the obligation to protect this most valuable service. If this responsibility cannot be redeemed by the State, it should not own the land. But States cannot cross their boundaries to manage the range lands on the watersheds of a neighboring State, even though they utilize most of the water yielded. California and Arizona, for instance, cannot pretend to manage the watersheds of the Colorado River in Wyoming, Colorado, and Utah which silt up their reservoirs and yield the water that they value so highly. Oregon cannot manage the watersheds of the Owyhee River in Idaho nor can Washington specify plans for the watersheds of the Columbia River in Idaho. Where interstate dependencies become so complicated, the only solution is Federal control of important interstate watersheds.

A Program For Wildlife

That wildlife in America—animals, fish, and birds—has not received the recognition which its importance justifies is now realized. Hunting, fishing, trapping, and the recreational opportunities so closely interwoven into their enjoyment are major factors in the social and economic development of the West. Fortunately, if properly managed, the environment required by this valuable resource of range lands can be maintained without serious interference with use for other essential purposes.

"Single use" for game will be necessary on only a limited area. Even on game refuges and bird sanctuaries, watershed protection will be furnished and recreation may be allowed with some restriction. Use by domestic livestock should not, however, be allowed on some limited areas of especial importance to wildlife, such as: (1) Nesting and feeding refuges for migratory waterfowl located at key points along the paths of flight, (2) winter range for big game where there is a critical shortage of feed for this season, (3) special areas to preserve species in danger of extinction. Closure to domestic stock because of such exceptional requirements for single use, cannot be determined from information now available. Undoubtedly part of the 20.5 million acres proposed for public acquisition for wildlife, as previously discussed, will need to be closed. Approximately 2.8

million acres are already closed for wildlife on national forests. In the aggregate the area requiring closure, however, will probably not exceed 1 or 2 percent of the range land.

JURISDICTIONAL PROBLEMS

The present system of handling wildlife on Federal lands whereby the various States claim exclusive right of control of the game within their boundaries is not working out satisfactorily. Under it, the kind of management which will give the maximum sustained contribution from wildlife and adequately protect the forage resource upon which the game is dependent has not been possible. The separation of the control of game from the control of the environment in which they live presents a serious problem which justifies earnest consideration. So far the wildlife has suffered. The prompt adoption of some effective arrangement which will make possible the initiation of desirable management practices is badly needed.

In the light of established precedents the first attempt should be to strengthen greatly the basis for cooperation between the States and the Federal Government. State laws which will permit of flexibility in treatment according to the needs of special cases and under which prompt action is possible are required in most States. In those States where a really workable plan for cooperative action cannot be worked out, the handling of wildlife on Federal lands should be turned over to the Federal Government. The problem is too acute to permit of the delays in action which now result from uncertainties as to the management of this valuable resource.

Any system of control must include wildlife on private lands and be such as to assure the retention of the hunting privilege for the average American. This precludes any system of control which tends to vest ownership of game or of the hunting privilege in the hands of private landowners. Some provision should, however, be made for a reasonable return to the owner for the public benefits derived from wildlife management and to induce his interest in maintenance on his land of an environment which is favorable to wildlife restoration. Such compensation may be in the form of a permitted fixed charge for hunting on the land, a permitted fixed charge for the game taken on the land, or a public subsidy for use and management of the land for wildlife as a national resource. The most logical solution of the ownership problem on lands or streams of exceptional public value is the acquisition of such property by some suitable public agency.

REFUGES AND SANCTUARIES

The management program must include maintenance of wildlife numbers in balance with the available feed and other environmental factors. Refuges should be of a temporary rather than permanent character and under flexible regulation so as to permit prompt adjustments with changing needs. The same basic principles for the protection of the range will apply as for domestic livestock, including proper stocking, proper class of stock, proper seasonal use, and distribution. Many small refuges usually are preferable to a few large ones in effecting wider distribution of game, in securing a

more efficient utilization of the range as a whole between game and livestock, in better provision for specific needs such as for seasonal use and in providing for a less cumbersome and more flexible handling of management adjustments.

The present system of licenses and law enforcement is not meeting the requirements of wildlife management. Under it there is a lack of flexibility which prevents immediate action on problems which arise. Too often game wardens or commissions lack the legal authority to handle the game resource effectively. Ranges already overstocked with game are now handled under laws which are designed primarily to build up numbers. In most States no legal provision is made to keep game numbers down to the grazing capacity of specific problem areas. Authorization to issue special permits with or without restriction as to number or sex of the kill and to employ a scheme of selection by drawing lots or some other equally fair system for the distribution of permits is needed in most States.

It is unfortunate that in most States the selection of game officials continues to be based on political preference. Really effective game management cannot be expected until selection of the responsible personnel is made on merit, usually under a civil-service system. It is equally important that game management be recognized as a profession and that a very high percent of the game officials be selected because of technical training in that especial field, coupled with adequate field experience. Wildlife management courses are now offered by several universities and should partially meet the problem of supplying trained men. Special training, broad experience, and a feeling of security in the job are nowhere more urgent than in this field.

Another factor in maintenance of forage and of numbers (livestock as well as game) is the suitable control of predators and of rodents. Control should aim toward effecting a balance rather than to seek extermination and will require careful consideration of relationships and of local needs.

The possibilities of artificial planting of birds, fish, and animals is by no means exhausted and needs consideration. This fits in with the idea of maintaining many small refuges, of obtaining a wider wildlife distribution, and of helping to relieve areas of congestion through removal and transplanting of surplus animals. However, such planting must avoid conflicts with other essential uses. Projects should be approved only after careful, thorough study of the conditions, needs, and possible effects. For example, the planting of elk in some places has resulted in the overstocking of ranges badly needed for domestic livestock and injury to adjoining ranches and farms.

Comprehensive management plans, local, regional, and national, must be prepared. The aim should be toward restoration and maintenance of wildlife habitats and production of wildlife on a sustained yield basis. Only through the preparation of thorough, systematic plans can this attractive and valuable resource be restored and maintained at a level that will insure maximum contributions without excessive conflicts with other uses.

A Program for Recreation

The spiritual, social, and economic importance of recreation as a form of land use in the West has been shown earlier in this report. The increase in this form of use has been almost phenomenal. The number of people so using the national forests, for example, increased from slightly more than 3 million in 1917 to more than 38 million in 1934. The national expenditures for such use now exceed 1¾ billion dollars annually and both numbers and cost seem definitely to be increasing. Improvements in automotive transportation and increases in road mileage where recreational facilities predominate, as well as increase in leisure time, all lead to the conclusion that this use will continue to grow.

The open range lands furnish an essential part of the recreational opportunity of the West. Desert outings during the spring flower season; dude ranches, based on the perpetuation of the spirit of the Old West on a de luxe scale; concentrations of use by tourists in especially attractive canyons; and use in varying degree of an untold number of resorts and camp grounds are now common and will increase.

The use of the range country for recreation seldom need interfere seriously with other uses. On some small areas, where heavy recreational use might result in pollution of intensively used domestic water supplies, recreation may have to be restricted or excluded. Similarly, some wildlife nesting or breeding grounds may have to be closed to recreational use during critical periods.

Conversely, in some areas of especially high recreational value, where concentration of people is common, it may be desirable to exclude livestock at least during some periods of the year. Normally, water supply intakes for use on camp grounds and heavily used camping areas should be fenced against livestock if this is a problem. In such instances the limited value of the forage resource left unused, as compared to the high recreational values involved, will leave little basis for objection to such closure. Normally, careful planning will make possible full recreational use without restricting either livestock or game.

That recreational use is an important source of income to the range country is coming to be realized. Many ranches which formerly depended entirely on livestock for their income now supplement this with the returns from a dude ranching business. In fact, on many of these ranches the recreational venture now predominates and the livestock operation is little more than a feature to attract and entertain the guests. Thus more and more the romance of the range livestock outfit is being capitalized into a sound, flourishing industry. The development of recreational use of the range can no longer be passed aside as an insignificant feature, rather it promises to be a major factor in the social and economic life of this country. Thus, emphasis should lead away from complete closure to livestock of areas for recreational use. The total forage value of areas which must be so closed will be so small that grazing capacity of the range as a whole will not be measurably influenced.

A Program for Forest Ranges

Included in the range area is about 154 million acres of forest land. Approximately 78 million acres of this is capable of producing commercial timber. Practically all of the forest-range area is of importance in watershed protection. It is principally summer range for cattle, sheep, and wildlife. It is also extensively used for recreation.

Accordingly, management of the forest-range area presents a problem of interrelationships of considerable importance to the West and Nation. Generally, such livestock management as will insure sustained forage production and the restoration of depleted areas will also effectively safeguard timber production and other uses. In some instances, special silvicultural measures will be necessary. Overgrazing and improper seasonal use, especially winter grazing of commercial forest areas where snow remains, must be overcome where they still prevail. The practice of promiscuous burning, in an effort to improve forage, wherever it endangers commercial timber production or important watershed values, must also be overcome.

In general, climatic conditions are more favorable on forest ranges than on the drier types at lower elevations. Accordingly, forage conditions, if not too seriously depleted, can be restored rather readily under proper management and still permit use of the forage. It is in the interest of the livestock producer to assure soil and forage maintenance and such livestock management as will safeguard other uses of forest lands.

Additional Information—A Basic Need

Enough information is already available for marked progress in the program for restoration and management of range lands. To carry out the program fully and to make it serve most effectively will, however, require the accumulation of more exact information.

More facts are needed on the true relationship of the range and its use for domestic livestock, watershed protection, wildlife, recreation, and timber production. Improved management principles must be developed, additional possibilities for artificially reseeding ranges determined, and other phases of use and management developed. Economic studies should determine more exactly the social and economic relationship of the range and how it can best serve the livestock industry, communities, the State, and Nation. A comprehensive resource and economic survey to strengthen existing data is also urgent. Not only should such a survey include an inventory of the amount and quality of forage available for domestic livestock and wildlife, watershed conditions, and other resource values, but it should also provide the basis for the coordination of range use with crop production and the whole economic structure of integrated agriculture and dependent communities in the range territory. The size and importance of the required research program are fully developed in a later section.

RESEARCH AND EXTENSION PROGRAM

By W. R. Chapline, Chief, and R. S. Campbell, Senior Forest Ecologist, Division of Range Research

Why Range Research and Extension?

Every section of this report, in one way or another, reflects the inadequacy of present handling of the range resource and the need for technical information as a basis for range restoration and management. Lack of knowledge, the inevitable result of the lag of research, has been an important factor in the widespread overgrazing, unseasonable use, and other mismanagement now prevailing. Lacking usable ways of measuring range deterioration, it has often not been recognized until production failed in critical periods. Consequently, the 88 percent of the Nation's land area in range fails to yield its maximum wealth and social benefits.

Calf and lamb crops are only one-half or two-thirds as large as they should be; animals develop poorly; and markets, profits, credit, and other financial aspects of the livestock industry are adversely affected. Lands, incapable of supporting families on a satisfactory living standard, remain in private hands, draining the life savings, as well as the hopes and aspirations of their owners.

The present flood menace, impaired stream flow, and serious silting of irrigation and other reservoirs, which directly or indirectly affect most western communities and nearly 20 million acres of irrigated lands, have been allowed to develop. These conditions are chiefly due to deterioration of range cover and the resulting abnormal erosion of range lands as indicated by studies so far made. These studies in turn stress the immediate need for greatly expanded research to determine the necessary understanding of grazing, soil, and other watershed relationships.

The conflicts between grazing and wildlife, the destruction of food and cover, and the silting of streams, have limited hunting, fishing, and other recreational opportunities.

That such conditions need not prevail has been demonstrated by the better resource, social, and economic conditions on national forests and on those private ranges where better management, based on research, has been practiced. Even there, however, the lag of research has been a tremendous handicap to restoration of range, watershed, and other values and in securing the maximum return from sustained production of forage and livestock.

Viewing the range situation in its broader aspects, a program of research and extension sufficiently comprehensive to meet national, regional, and local requirements is justified:

1. To develop management principles and other necessary means to insure restoration, within a reasonable period, of range values on the 675 million acres—93 percent of the range area—which is now depleted.

2. To develop the management principles applicable to the range area and its component parts which will insure sustained forage and

livestock production and maximum returns to livestock producers and the public generally.

3. To develop satisfactory understanding of the interrelationships of the various uses and services of range lands, which include grazing by domestic livestock and game, timber production on forest ranges, watershed protection, and recreation; and to determine adjustments necessary to safeguard values and gain the greatest public benefits.

4. As a basis for developing sound administrative policies for the 353 million acres of range land now publicly owned or controlled.

5. As a basis for determining what areas should remain in private ownership and what should be acquired by public agencies because of submarginality or high public values.

6. As an aid to the private owner of range land and of the livestock grazing on all ranges, in restoring range values, improving management, bettering marketing and credit facilities, equalizing taxation, developing economic units, integrating range land production and use with crop and other related agriculture, and generally increasing the social and economic security of the 4-billion-dollar range livestock industry and dependent communities.

7. As an aid in and basis for national, regional, and local land-use planning and the development of private and public policies, affecting the range area.

Major Lines of Research Required

Research on range lands may be grouped into several broad lines of work including, among others, range management, artificial revegetation, watershed management, range economics, wildlife, animal husbandry, and entomology.

Range Management

The purpose of range-management studies is to develop methods of grazing, consistent with the conservation and use of other resources of the land, that will, under the fullest possible use, restore and maintain the forage and produce livestock most effectively. Range management as here used is considered to include such fundamental research as ecology, soil science, and other botanical studies essential to an understanding of the growth requirements and growth habits of range plants, and their response to grazing. It also includes studies necessary in the development of systems of grazing, in determinations of grazing capacity and proper seasonal use, in improving methods of handling livestock on the range, and in developing other features of range use by domestic livestock. These studies center primarily on the range resource and deal with problems of handling livestock on the range primarily from the standpoint of range forage use and more economical handling.

As has been indicated earlier in this report, forage conditions differ widely throughout the range country; this variation has been intensified by various degrees of depletion, both of forage and soil, within each main forage type. Preliminary studies indicate that, if given the chance, the climax species in each type, generally de-

sirable grasses and other plants, will maintain themselves or even improve if not too seriously depleted. In many cases, where the stand of such plants has been greatly thinned, aggressive secondary species have occupied the soil, or the soil fertility has seriously diminished, it will take time and very careful management, adjusted to growth needs of the better plants, to restore a satisfactory cover.

The complex character of the present problem is illustrated by the extreme demand for spring-fall range in the intermountain region. Because of abuse the valuable perennial grasses have been largely replaced by sagebrush and the aggressive annual downy chess, or "cheat grass." Lacking better feed, stockmen graze this vegetation during the few weeks it is green and thus prevent the reestablishment of more valuable perennial grasses, which would ultimately furnish more abundant feed for a longer period. The development of management which will accommodate as much as possible of the grazing demands and yet facilitate restoration of a better cover, requires study of all the involved factors as well as an understanding of the practical needs.

PROGRESS AND NEEDS

Progress may be grouped into three broad phases: (1) The development or improvement of management principles; (2) the determination of some of the more important relationships between livestock grazing and other uses of the range; and (3) the development of some of the fundamental knowledge, basic to the management of the range resource.

Under management principles the outstanding results include: (1) Recognition of the necessity for conservative stocking of ranges on which perennial bunchgrasses are dominant to assure sustained forage and livestock production and to provide a feed reserve for drought contingencies; (2) the development and improvement of several systems of grazing which, with modifications to meet local conditions, have rather wide application, such as the deferred and rotation system which permits full use of the forage but delays grazing until after seed dissemination on a different portion of the range each year; (3) important modifications in seasonal use of mountain ranges to lessen or avoid damage to forage or soil; (4) a fairly good basis for determining the approximate grazing capacity of the mountain range types and some of the more arid types; (5) improved methods for grazing sheep and goats, such as open and quiet herding, and bedding them down in a new place every night, to avoid damaging the range through trampling and localized overgrazing; and (6) obtaining better distribution of cattle on the range through well-placed watering places and better salting methods, thus bringing about more even and more effective use of the available range forage.

The application of these results, particularly on the national forests, has hastened restoration of depleted ranges and facilitated better livestock production and greater stability of that portion of the industry. They illustrate the value and applicability of range research. The success of these results, however, stresses the opportunity for still further improvement through research.

On the Coconino Plateau in the Southwest and various other localities, the main causes of damage to timber reproduction from livestock grazing have been determined, and principles of management are being developed which indicate that most of the damage can be overcome. Much additional research of this kind will be essential as forest practice and range management become more intensive.

A start has also been made in the Southwest and Intermountain Regions in determining the general relation between grazing and watershed protection. Soil is the basic resource. Satisfactory forage and other growth depends upon its maintenance. Water from range watersheds is of vital significance to the West. The prevention of the silting of reservoirs is also outstandingly important. Excessive grazing has so generally impaired watershed values that range-management research must consider watershed needs.

Only a meager beginning has been made in determining the relationship between domestic livestock grazing and wildlife conservation. Most studies have emphasized one phase or the other. The increasing numbers of wildlife, however, greatly intensify the need for a full understanding of these relationships.

The quest for fundamental information, which will undoubtedly furnish the basis for the big advances in potential range management, has but begun. Considerable general information, largely observational, has been collected regarding the forage values of range plants, based upon the extent to which they are eaten by livestock. Similar observations of the habitat relationships of many of these plants have been made. Their classification and description are well advanced. The chemical characteristics and poisonous properties of many of the more important poisonous plants have been determined. On the other hand, the growth characteristics, habits, requirements, physiological processes, including the chemistry of growth, reproduction, food storage, etc., of range plants and their reaction to grazing, have been studied in detail only for a few of the most important plants and in a few localities. This is also true of the competitive relationships, response to climate and soil, and other requirements of the associations of range plants.

In brief, the research performed to date has furnished a fairly satisfactory background for a demonstration of proper grazing in the national forests through determination of a few of the main principles underlying forest-range management. It has made, in a few places, a satisfactory beginning on some of the fundamental problems underlying forage development and use. In several localities research has shown that damage to forest reproduction and watersheds may become very serious; it has indicated, in part at least, the remedial or control measures which are effective.

Future work, requiring most emphasis, includes a more comprehensive and fundamental determination of: (1) The palatability and nutrition value of each of the plants which compose the range forage; (2) the life histories and ecological relationships of all forage plants and associations; and (3) the ecological and physiological reaction of all plants to livestock use. The results of these three groups of investigations will be invaluable guides in applied research and in the application of range management.

The outstanding problems of applied research concern the further perfection of systems of grazing and a more exact determination

of grazing capacity, including the effect of its many influencing factors, and the perfection of livestock management on the range. All research, however, whether fundamental or applied, must constantly consider such primary requisites as preservation of soil and cover conditions so essential not only to the production of maximum forage crops but also for satisfactory maintenance of other land uses and services.

ARTIFICIAL REVEGETATION

The principal objective in artificial revegetation research is to develop low-cost methods and suitable species for seeding or transplanting on 38 million acres of range lands now so badly depleted that reasonably rapid natural revegetation appears improbable. At least one-fourth of this depleted area consists of abandoned fields where cultivation has completely destroyed the native sod. Both forage for livestock and watershed protection values are at stake. If suitable species and low-cost methods can be developed for large areas of semiarid range, the total acreage to which these investigations would apply would be greatly augmented.

PROGRESS AND NEEDS

Various tests of cultivated species, already in use in more humid parts of the United States, have been made on certain western mountain ranges. Kentucky bluegrass and timothy, among others, have proven adapted to favorable sites where soil and moisture conditions are satisfactory. A badly denuded range in the Wasatch Mountains of central Utah, for example, which required about 10 acres to support a sheep for 3 months, was sown to Kentucky bluegrass; at the end of the ninth year 1 acre of this artificially reseeded range would support a sheep for the 3-month season. Crested wheatgrass and smooth bromegrass have proven of value for use under somewhat drier conditions on northern ranges. Most of the seeding tests, however, indicated that the plants tried were unadapted, especially on semiarid areas. It is just as important to ascertain that certain plants are unsuitable as it is to determine which ones can be used, in order to avoid useless expenditures on large-scale attempts at artificial reseeding.

A few of the more important native grasses, such as slender wheatgrass and mountain brome, have proved especially valuable for range reseeding purposes; several other herbaceous plants and some shrubs have demonstrated their worth for reseeding or transplanting for erosion control.

As yet no satisfactory plant material has been found for artificially reseeding semiarid ranges; transplanting under such conditions is costly. Notwithstanding, millions of acres of those lands demand rapid restoration because of large dependent values for watershed protection, livestock, and game. The spring and fall ranges in the foothills are of even more critical importance, as but few species have been found suitable for such conditions.

Studies have been conducted in only a few localities of sufficient intensity to determine why artificial reseeding has succeeded or failed. Such investigations are needed, however, in all parts of the West.

Search for promising forage and erosion-control plants should be made in all foreign countries having growth and climatic conditions comparable to our western range area in order, if possible, to supplement the few adaptable introductions now available and the promising native species. Plant breeding, selection, and hybridization, as applied to range species and conditions, hold untold possibilities. High-yielding and disease-resistant strains of wheat and other grains, as well as fruits, have been developed through research. Comparable experimentation with native and introduced range vegetation should yield similar returns and the long hoped for drought-resistant forage plants now so urgently needed for restoration of range and watershed values.

WATERSHED MANAGEMENT

The main objective of range watershed research is to perfect methods of managing ranges that will afford essential watershed protection, including delivery of the greatest supply of usable water, control of erosion, and regulation of stream flow. The determination of methods for managing impaired watersheds to restore their utility is a distinct phase of the problem.

Research, to date, has disclosed that perennial herbaceous vegetation, especially grasses, is the most effective cover for erosion control on semidesert untimbered ranges of the Southwest and on alpine watersheds in central Utah. Such cover is also very important in the open pine stands of Idaho. Research has also indicated the value of restoring the herbaceous cover on depleted ranges in reducing surface run-off and erosion from summer rains, in increasing absorption of precipitation by the soil, in checking summer flash floods, and in improving the productive capacity of the watersheds. It has also given some indication, in a few localities, of the value of erosion-control dams, water-diversion works, contour terraces, débris basins, and other similar engineering works.

These rather localized investigations indicate the great value of such research in correcting a situation which has become critical over most of the West. Similar studies should be undertaken in all other important range types and watershed conditions. Depletion is so general that the extent, nature, and causes of present watershed impairment and usable indicators of early watershed deterioration should be defined so that remedial measures may be promptly applied.

Although restoration to virgin conditions is undoubtedly desirable, it will be, at best, a long and slow process in many areas. Accordingly, definite data are needed concerning the most practical cover which can be obtained rather promptly for reasonably satisfactory watershed protection. Determination of the optimum watershed cover for each important condition, however, is also essential. The range cover on watersheds is so closely interrelated to the range livestock industry and the social and economic welfare of the West that additional research is required to determine how much the cover may be modified or utilized without sacrificing its ability to retard run-off, build and bind the soil, aid water percolation, and otherwise control erosion and stream flow.

RANGE ECONOMICS

The major work to date has featured studies of wool production, livestock-production costs in several States, surveys, and a few intensive investigations of ranch organization and management, determination of the basis for grazing fees on the national forests, local land-use studies, and preliminary phases of other economic aspects.

One important phase which justifies early initiation is a comprehensive range-resource and economic survey involving such features as the area, location, and ownership of range land, its actual and potential grazing capacity, and the most effective coordination of the use of range land with other agricultural land. The results in this report have provided a conception of the national and regional extent of the resource, of some of the vital economic problems in range use, and of broad social and economic changes which must be made. It is clearly evident that a more intensive survey providing for an inventory of the range resources and more exact information concerning changes needed is essential to furnish the basis for further national, regional, and local land use and agricultural planning and adjustment. Many of the surveys already completed for development of management plans or recommended in other parts of this report will aid materially in the assembling of necessary information.

Additional studies of production costs and ranch organization are needed to disclose the most economic size of enterprise, the proper balance between range and crops, and how ranch organization may be revised to produce livestock, livestock products, and feeds more economically. Closely related to these are the needs for studies of range-land use, especially the determination of lands submarginal for private ownership. The range-livestock industry will further benefit from more detailed investigations of credits, marketing, taxation, and other financial entanglements which encumber the business.

WILDLIFE

Most research on wildlife has concerned taxonomic relationships, the food habits of a few major species, and the control of injurious rodents and predators. The outstanding problem is to provide a technical background for the restoration and maintenance of desirable wildlife. This should be supplemented by closely related research on life habits and the specific place of each species in its environment. Such basic knowledge will be of great significance in the development of a really effective technology of conservation and control.

If wildlife for food, fur, or recreation is to be produced on the range, where it rightfully belongs—in fact as the maintenance of the desired biological balance in certain cases obligates—particular advantage will result from sustained output. What numbers can be maintained and what may be removed annually without reducing breeding stocks below the safety point must be determined. When these things are known, limitations may be placed on season, age, sex, and numbers that can be removed, based on an understanding

of the life histories and ecological relationships of the animal concerned. That method would be far more permanent and secure than the unsatisfactory empirical foundation upon which existing game laws in the United States are based.

Research should also determine existent values and necessary adjustments in other wildlife. Birds, for example, may spread plant diseases and consume seeds; on the other hand, they also plant seeds and prevent or shorten insect epidemics by preying upon injurious insects. Burrowing rodents improve the tilth of soils. Rodents, however, consume enormous quantities of forage. Predatory animals, such as coyotes, wolves, and mountain lions, although beneficial in their consumption of rodents, often destroy so much livestock that they seriously affect business profits. Control of wildlife detrimental to range and livestock must depend upon the ecological relationships of each animal and its life habits, such as preferences for food.

All problems involving ecological relationships, life histories, protection, and wildlife management, must be attacked not as distinct studies which in themselves are final objectives, but rather as parts of a much broader system of range-land management, which includes forage for livestock as well as wildlife, watershed protection, timber production, recreation, and possibly other uses and services of the land.

ANIMAL HUSBANDRY

The improvement of breeding herds and flocks on the range and the control of diseases constitute the outstanding achievements in range animal husbandry. Much still remains to be accomplished, however, in improving livestock types for range use through selection and breeding, in controlling diseases and parasites which affect range animals, and in studying the economic wintering of range livestock. Improved nutrition for range animals offers tremendous research possibilities, especially since forage depletion necessitates the grazing of many secondary or even low-value species and involves the feeding of essential minerals and other supplements.

ENTOMOLOGY

Range entomology and other special phases of zoological research may be justified where high economic values are at stake. Cases in point include the beet leafhopper and locust infestations in many parts of the West, where the pests breed chiefly on overgrazed range lands and often migrate to nearby irrigated areas, thus causing great damage both to the range forage and cultivated crops.

COORDINATED RESEARCH

The preceding program of research on range lands has emphasized individual lines of investigation with only minor reference to the relationship of one to another, but the inter-relationship of problems and work is obvious. Sound principles of management can be devised only by coordinated study that weighs all values and utilizes the fundamental sciences which bear upon the problem.

Since the range problem is agricultural, its research must logically be coordinated closely with allied research of the Department of Agriculture and the State agricultural experiment stations.

Extension

Range extension consists primarily of educational and demonstrational work designed to disseminate practical information concerning range management. It seeks also to spread applicable knowledge of range management among the owners, users, and managers of range lands and to demonstrate and interpret desirable range-use practices adapted to local conditions in order that range lands may perform their fullest potential services, both economic and social.

A limited amount of such work has been handled by extension livestock specialists and some county agents with desirable results in most of the Western States. Considering the widespread depletion on privately owned ranges, direct assistance to individual range-livestock owners, in formulating management plans and applying improved range practices should be at the fore of any such program. A sound management plan is just as essential for proper handling of the range as is a blue print in building construction. Extension workers should provide stockmen with the latest research results on revegetating the range, on stocking to safeguard against drought losses—in fact, on all the results of the previously outlined studies. Extension also might well popularize cost-keeping systems. The net result of this extension work would be a much-needed coordination of individual welfare and production with regional and national requirements.

Responsibility for and Cost of Research and Extension Required

The Federal Government has direct responsibility in range research on Federal lands, on national problems, and on regional problems. The 287 million acres of federally owned or controlled range lands require research as the basis for sound management. The 67-percent depletion on unreserved public domain and grazing districts occurred under Federal jurisdiction, and implies Federal responsibility for restoration. Many of the range problems have national and regional significance. The use of range lands as a part of the integrated agriculture of the West has never been fully appreciated, but its importance is outstanding, not only to the West but to the Nation. Thus, from all aspects, the Federal Government has a responsibility to carry the major burden of research and at least half the burden of extension on western range lands.

Federal research on range problems is conducted primarily by the Department of Agriculture; the Bureau of the Census has compiled valuable statistical data, and the Tariff Commission has made certain studies of wool and livestock production. The McSweeney-McNary Forest Research Act of 1928 authorized range investigations, and under its provisions and the general authorizations of the agricultural appropriation acts the Forest Service has conducted a coordinated attack on range management, artificial revegetation, watershed management, and certain phases of range economics. Such research is now in progress at five of the six regional forest and range experi-

ment stations in the West. Other research has been handled independently or in cooperation with the Forest Service by the Bureaus of Plant Industry, Animal Industry, Agricultural Economics, Biological Survey, Chemistry and Soils, Soil Conservation Service, Entomology and Plant Quarantine, and the Weather Bureau.

The States have a responsibility for range research on State-owned range lands and on local problems. States are also coming to recognize their responsibilities for cooperation with the Federal Government in handling the regional and national problems. All of the State agricultural experiment stations of the 17 western range States have done some work on range problems. Although some of this research has been conducted independently, much has been carried on in cooperation with one or more bureaus of the United States Department of Agriculture.

A broad field of fundamental scientific investigation is open to quasi-public and private research institutions. Many botanists, zoologists, and other scientific workers in colleges and universities have given incidental attention to problems which directly or indirectly affect range vegetation and animal life. Much of the early taxonomic research on range plants was performed in this way, and considerable similar work still continues. Many important discoveries in plant physiology, ecology, and biology have been made by university experimenters. Research opportunities along these lines are practically unlimited, and when combined with graduate work of men in training for range-research positions, may further the entire program. Such agencies as the Carnegie Institution of Washington, the Boyce Thompson Institute for Plant Research, the Southwestern Arboretum, and similar though less prominent agencies may all contribute advantageously to the range-research program.

In developing such a comprehensive program of research a highly trained personnel will be essential. Much of the research up to the present has been preliminary and empirical. That of the future should be more concerned with fundamentals. The demand for well-trained college graduates in range-management work has always been good. For research positions, men with advanced training and of exceptional ability will be needed. To facilitate the development of such men, additional fellowships should be established. They should be available only to the more able men and centered in the stronger institutions.

PRESENT EXPENDITURES

Present expenditures by all agencies for research on range-land problems total approximately $750,000. Expenditures of the Department of Agriculture cover most of this, primarily centered in the Forest Service.

It is estimated that present expenditures for range extension aggregate approximately $50,000 annually, wholly insufficient when distributed, although not equally, among 17 States. It is practically impossible to estimate the actual cost because so much of the work has been handled more or less incidentally to other extension activities.

PROPOSED EXPENDITURES

In view of the lag in range research, the present depleted condition of the resource, natural factors retarding range restoration, and the multiplicity of range problems now requiring study, an annual expenditure about four times the present as a 10-year program appears necessary. Of the total annual expenditures of $2,750,000 required for all research on range lands, which should be reached by 1947, the program of the Department of Agriculture would account for about $2,000,000 annually. States should assume responsibility for approximately $550,000 and other agencies about $200,000. Ten years is a reasonable period in which to expand the research of the agencies involved to the full extent of this contemplated program.

Authorizations for such a research program in the United States Department of Agriculture are already provided in the Agricultural Appropriation Acts and in the McSweeney-McNary Forest Research Act. The latter act authorizes annual appropriations of $275,000 for "range investigations" (primarily management and artificial revegetation) up to the fiscal year 1938, and after that year for "such annual appropriations as may thereafter be necessary." Specific legislative authorization of at least $400,000 for the range watershed management investigations is desirable, either independently or as a component part of the proposed national program for watershed research on forest and range lands.

In addition to the above amounts needed for the western United States, funds are required for range research in the South and in Alaska. Probably, $200,000 annually would meet the needs during the next 10 years for investigations dealing with range use of southern forest lands, with the full amount to be reached in the tenth year. In Alaska, approximately $100,000 annually will be needed.

The promotion of satisfactory management on the 376 million acres of ranges now in private ownership and of privately owned livestock grazing on publicly owned ranges requires the development of an extension organization during the next 10 years costing approximately $1,000,000 annually. This involves a joint participation by both the Federal and State Governments, supplementing the existing Extension Service activities. Since county agents and extension specialists are heavily burdened with other duties, the extension program on range-land problems should be carried out by either assistant county agents trained in range management or range specialists each serving several counties as a unit. Supervision should be furnished by the addition of range specialists to both State and Federal Extension forces.

LEGISLATION AND COSTS

By S. B. Show, Regional Forester, California Region, and E. I. Kotok, Director, California Forest and Range Experiment Station

A group of major problems requiring legislative action for solution have been stated earlier in this report. The problems concern handicaps faced by the private owner and operator which have tended to encourage mistreatment of land and to create an unstable business. They concern the public interest in continued productivity and full use of range lands and their resources. They concern, too, the question of managing public range lands so they will serve both private and public needs.

Part of these problems require Federal legislation, if a serious effort is to be made to fulfill the possibilities of the range; others can be solved by State legislation. Within each of these broad classes, some needs stand out as immediately urgent, while others though important can wait for attention. In the following pages these problems are briefly reviewed and the needful legislation is recommended. Under each recommended piece of legislation is indicated the conclusion of this report as to immediate urgency.

Problems Requiring Federal Legislative Action

PROBLEMS AFFECTING PUBLIC DOMAIN AND GRAZING DISTRICTS

IN WHAT DEPARTMENT TO PLACE RESPONSIBILITY FOR MANAGEMENT OF FEDERAL RANGE LANDS

At present, public range lands are administered by two separate agencies, one in the Department of Agriculture, one in the Department of the Interior. The public ranges, whether on national forests or on public domain, are inseparable parts of a whole. To be most valuable in the national economy, as evidence brought out earlier has shown, both should be used with private range and crop lands to build up balanced sustained-yield livestock production units of economic size. No matter how sincerely departmental coordination is sought, a single task clearly cannot be most effectively accomplished through split jurisdiction.

Recommended legislation.—The management of the public range lands and their resources is primarily a problem of conserving organic resources. On solution of it depends the permanent stability of much western agriculture, and the economy of the whole range region. Not only the forage resource, but soil conservation, watershed protection, and wildlife management, all a part of the range problem, are a recognized part of agriculture and are within the recognized jurisdictional fields of the Department of Agriculture. The fact that large areas of range lands require multiple-purpose

land management, a mode of control long established in the Department of Agriculture, likewise indicates that Department as the most effective agency to administer all federally owned range lands, excluding those on the Indian reservations managed but now owned by the Federal Government.

WHETHER TO PLACE ALL PUBLIC DOMAIN UNDER PERMANENT FEDERAL MANAGEMENT

At present, under the Grazing Act of June 28, 1934, only about half of the public domain (80 million acres out of 162 million acres) can be organized into grazing districts. This provision has the effect of blocking administration of large areas of range lands in which the Federal Government is the principal owner. Such areas are thereby left subject to the mounting ill effects of unrestricted grazing, which any close observer may readily forecast. In other areas, predominantly in private ownership, the remaining public domain forms but a small part, and an attempt to manage it would affect but little the area as a whole.

Federal management as provided by the Grazing Act might apparently be insecure, since section 1 of the act contains the clause, applicable to all lands, "pending the final disposal."

Recommended legislation.—The limitation on the area to be reserved should be removed, so that all suitable public-range land can be placed under management at once.

Public domain within areas which study shows to be unsuited for Federal range units should, instead of remaining open to patent under the land-disposal laws, be set aside subject to exchange for the purpose of acquiring private or State lands within grazing districts or national forests. Since building up of the range on the grazing districts will require capital investments, and since the remaining public domain is ill-adapted to private ownership, the implication contained in the words "pending the final disposal" should be removed from the law.

This legislation is of great immediate urgency.

WHETHER RANGES ON FEDERAL RESERVATIONS OTHER THAN NATIONAL FORESTS AND GRAZING DISTRICTS SHOULD BE ADMINISTERED

On the national parks and national monuments grazing is generally recognized as inconsistent with the primary purposes of the reservation. On the Indian lands, management of the ranges is highly important as an integral part of the whole job of administration. Plans already formed contemplate a type of management to make the range lands more fully serve the needs of the Indians.

But other large areas of Federal lands, primarily valuable as range land, are removed from entry as reclamation withdrawals, as military and naval reservations, as oil, phosphate, and coal reservations, and as reservations for lighthouse purposes. On such lands use of the range is generally not inconsistent with the primary purpose of withdrawal. On some of the reservations grazing is already permitted under a leasing system tending toward range depletion. On others grazing is as unregulated as on the public domain.

Recommended legislation.—Unless already fully authorized, provision should be made that, with concurrence of and under conditions

set by the Secretary of primary jurisdiction, the range-administering agency or agencies of the Department of Agriculture may undertake the job of range management on any Federal reservation.

This legislation is important but not immediately urgent.

RESTRICTIVE CLAUSES IN GRAZING ACT

The Grazing Act of June 28, 1934, sets up the following provisions:

1. A clause in section 3 forbids denial of renewal of a permit if such action will impair the value of a mortgaged livestock operation.

This provision has the effect of placing a premium on indebtedness, and invites misuse of indebtedness. It tends to continue inflated value for key tracts, such as waterholes, controlling large areas of range. It could be used to nullify efforts to obtain a distribution of permits which would most effectively stabilize use of the range and dependent communities.

2. The first part of the second sentence, and the last sentence of section 3 might be construed to establish and perpetuate grazing use as a permanent right, based on past and present occupancy and on ownership of water or water rights. These provisions are so ambiguous, however, that an unequivocal interpretation is impossible. If the apparent intent of these sections is the true one they have the effect of preventing the planned redistribution of grazing privileges that would enable individual operations of economic size to be built up, and of nullifying efforts to change the form of use where high and critically important public values are involved. In effect, they label the grazing districts as for the exclusive use of range livestock.

3. Section 15 establishes a minimum area of 640 acres in a single isolated tract that may be leased. There are a great many such tracts smaller than 640 acres which should not or may not be sold and should be leased, at least temporarily.

Recommended legislation.—The provisions cited under 1 and 2 above should be clarified or repealed. The minimum limit of 640 acres in a single tract that may be leased should be repealed. This legislation is immediately urgent.

AUTHORITY OVER GRAZING DISTRICTS

The first part of the second sentence of section 1 and section 16 of the Grazing Act of June 28, 1934, might be construed to make the State authority supersede the regulation of the Secretary on certain subjects and thereby materially to restrict the Federal Government in the regulation of range use on the grazing districts.

Recommended legislation.—These provisions should be repealed or the language clarified. Such legislation is of immediate importance.

CONSOLIDATIONS WITH NATIONAL FORESTS

The act makes no provision for giving grazing-district or public-domain land national-forest status, except in three States where it can already be done by Executive order, although careful study has shown that 26 million acres of Federal land should be added to round out livestock and game range units already chiefly in national forests, simplify administration, or include timber-producing lands.

Recommended legislation.—Provision for the transfer of grazing-district land to national-forest status by action of the President on recommendation of the National Forest Reservation Commission, and the Secretary of Agriculture, should be made. This legislation is of immediate importance.

WHETHER TO MANAGE FEDERAL RANGE LAND WITH THE SINGLE PURPOSE OF FURNISHING FORAGE FOR DOMESTIC STOCK OR UNDER THE PRINCIPLE OF MULTIPLE USE WITH FULL ATTENTION TO ALL THEIR RESOURCES

A large part of the Federal range possesses high public values for watershed protection, soil conservation, habitat for wildlife and recreation. Since the practicality of multiple-purpose land management has been amply demonstrated on the national forests, the question must be sharply raised why a comparable guiding principle should not apply to other public ranges.

Recommended legislation.—The broad guiding policy should be definitely established that all Federal range lands are to be managed for the benefit of all the people concerned, rather than for any one class. This policy implies that they will be managed under the principle of multiple use, by means of which all resources can be given full attention as local or regional conditions indicate. Even though on most range lands forage for domestic stock is the dominant or even exclusive use, the single-purpose management principle should be avoided. The obvious fact that diversified local economy, like diversified farming, is more stable in the long run than single-crop economy or agriculture, dictates coordinated use of all resources, and therefore multiple-purpose management of lands. Moreover, multiple-purpose management is necessarily conservative management, and insures perpetuation of the range resource. Clearly this is to the long-time financial advantage of the livestock operator and the public alike.

Legislation to establish this principle of management is of immediate urgency.

PROBLEMS OF TRANSFERRING PRIVATE LANDS TO FEDERAL OWNERSHIP

A further group of problems is concerned with the most effective steps which the public can take through increased ownership of range lands, to assist in stabilizing the range livestock business, and to protect the public interest in the 728 million acres of range land. They include the following:

WHAT DISPOSITION TO MAKE OF LANDS PURCHASED BY FEDERAL AGENCIES IN ORDER TO RETIRE THEM FROM AGRICULTURAL CROP USE

Restoration to range use of cropped land, unwisely subtracted from the finest range land, is an existing policy and program of the Federal Government. Whether to pass these lands again to private ownership, with the danger of repeating the cycle of improper use and depletion, or to consolidate them with other Federal range lands now owned or to be acquired and managed, is the question.

The land-purchase program of the Resettlement Administration includes formerly cropped land, for which the most effective use is as range lands.

That most such lands should be repassed to private ownership, with all the dangers of repeating the cycle of misuse and depletion, seems very doubtful. Rather it would appear desirable to retain much of them in public ownership, consolidate them with existing and future Federal range units and place them under the management of the Department and Bureau designated to handle such lands.

Recommended legislation.—The Secretary of Agriculture should, unless his authority is already clear, be empowered to determine whether such lands are qualified as to kind, character, location, and quantity, to become a part of Federal range or forest units. If he finds affirmatively, his action in so conferring the lands should be final.

This legislation is of immediate importance.

WHETHER THE FEDERAL GOVERNMENT SHALL ACCEPT RESPONSIBILITY TO ACQUIRE AND MANAGE RANGE LANDS SUBMARGINAL FOR PRIVATE OWNERSHIP

To the extent that the several States are unwilling or unable to undertake the task, the acquisition by the Federal Government of range lands submarginal for private ownership is the most effective way to free operators from a burden which robs their business of financial stability and impedes conservation of the range resources. That the problem exists on a very large scale is well known, and the questions are primarily how large it is and by what means of public action it is to be solved.

A realistic approach will naturally recognize the inability of private ownership to solve a problem which forces beyond its control have largely created, and will take into account as well the fact that rehabilitation costs and low immediate income makes such an investment in long-term economy desirable for only the strongest units of government.

Recommended legislation.—The law should declare that private range lands which, because of financial pressure, cannot be adequately managed by private ownership, should be acquired and managed by public agencies. Range lands purchased by the Resettlement Administration should be included. There should be a declaration that decision in each State as to whether the State or the Federal Government should undertake all or each a part of the whole job will be made by negotiation between appropriate State and Federal agencies.

For effectuation of the acquisition program determined as the Federal share, State consent as provided for timberland purchases should be a prerequisite. The National Forest Reservation Commission should be designated and empowered, as a competent existing agency, upon recommendation of the Secretary of Agriculture to determine with finality the boundaries of Federal range-land purchase units and to settle all matters of purchase policy.

This legislation is of great immediate urgency.

WHETHER FEDERAL GOVERNMENT SHALL ACCEPT RESPONSIBILITY TO ACQUIRE AND MANAGE RANGE LANDS POSSESSING HIGH PUBLIC VALUES WHICH CANNOT BE PRESERVED AND TEND TO DETERIORATE UNDER PRIVATE OWNERSHIP

Where high public values exist on range lands, land-management costs to conserve them ordinarily means relinquishment of immediate income. Since machinery is lacking to reimburse private ownership for such self-denial and self-discipline, the job of land ownership and management falls naturally to public agencies.

The answer to the question, then, must take into account whether interstate values are involved, whether States are financially equipped to handle, and similar considerations.

Recommended legislation.—The law should declare that private lands vested with high watershed protection, wildlife range, or recreation values which cannot be adequately preserved and which tend to deteriorate under private ownership should be acquired and managed by public agencies.

Procedure in determining the share of the State and Federal Governments, and in effectuating the agreed-on Federal responsibility, should be the same as under the section above.

This legislation is of immediate urgency.

SETTING OF FINANCIAL RELATIONSHIPS BETWEEN STATE AND FEDERAL GOVERNMENTS IN THE MATTER OF RETURNING PART OF INCOME FROM THE LANDS TO LOCAL GOVERNMENT

As part of the Federal undertaking in range ownership, both present and future, a question of very real moment is how much of the income should be returned to local government in lieu of taxes. The plan of returning 25 percent of gross income from the national forests has been followed for many years. Studies so far made of the operation of this plan have shown it to be on the whole fair and equitable. Additional study of the entire question is needed, especially since on Federal lands in general the return to local government now varies from nothing on some kinds of reservations and on the unadministered public domain to 50 percent in the grazing districts.

Recommended legislation.—Further study should be provided for determination of a fair division of income with local government, and then legislation to effectuate the conclusion will be needed.

This legislation will then be of immediate importance.

CONSOLIDATING OWNERSHIP WITHIN GRAZING DISTRICTS AND WITHIN NATIONAL FORESTS

The task of consolidating ownership in and adjacent to grazing districts and national forests is a formidable one. One important means to speed up the process is through the exchange of lands of equal value or the use of the range over a limited period of years as a base for exchange in the acquisition of private lands needed to round out public holdings. This principle of action has already been set in the exchange legislation long used in handling the comparable problems of consolidating timberland ownership in the national forests and has worked successfully.

Recommended legislation.—Broadening legislative authority is highly and immediately desirable.

FACILITATING DONATION OF LANDS TO THE UNITED STATES

Many owners of range land would willingly donate their properties to the United States in order to avoid heavy carrying costs and so that the productivity of the lands might be restored. That few donations are made is due to the legal cost to the private owner of furnishing title, and the common accumulation of unpaid taxes, without the satisfaction of which title acceptable to the United States cannot be given.

Recommended legislation.—The United States should be authorized, in connection with donations of range lands which fit into Federal range units, to pay the legal cost of title, and if necessary to clear title, to pay accumulated taxes in whole or in part. In no case should the sum of these payments exceed the appraised value of the property.

SIMPLIFICATION OF BOUNDARY CHANGES

An act of Congress is now required to extend boundaries of national forests in most of the Western States, and such action is often taken only after a measure has been considered several times. Since many States have already passed acts authorizing the Federal Government to acquire land for national forests, it has become increasingly evident that most of the former opposition to national forests has been replaced by active support. More expeditious machinery for boundary changes is therefore needed.

Recommended legislation.—The President should be authorized upon recommendation of the National Forest Reservation Commission to add to the national forests from lands owned by the United States, land areas determined by the Secretary of Agriculture to be chiefly valuable for national forest purposes and which can be economically administered as parts of national forests.

This legislation is immediately desirable.

RESERVATION OF SURFACE RIGHTS IN MINING-LAW PATENTS

Existing mining law, because of the wide variety of materials which can be "located" and patented, readily permits holding key areas required for public use, even though no show of a profitable mining operation is made. Such key tracts are often vital in economic and efficient use of the range.

Recommended legislation.—Separation of surface and subsurface rights in mineral claims and patents, leaving title and use of the former to the United States except to the degree required for operation of the mining claim, is highly desirable.

THE PROBLEM OF LAND-DISPOSAL LAW

Existing public-land laws, having as their effect the passage to private ownership of (1) lands poorer in quality than lands already a problem in private ownership, and (2) lands possessing key value in controlling use of surrounding lands are generally recognized as archaic.

Recommended legislation.—Although there is every indication that the transfer of land from Federal to private ownership is now

largely history, the danger is always present that the mistakes of the past will be repeated if existing statutes remain in effect. New legislation should take into account such things as the desirable line between public and private ownership, the phase of agriculture for which the land is best suited, the size of the unit required, etc.

With the exception of the mineral lands, there should be a clear declaration of intent to retain in public ownership all lands not affirmatively found to be adapted to private ownership. The finding of adaptability should be based on land classification made by a professionally competent agency under the Secretary of Agriculture. The classification should take into account the true income-producing value of the land in the local economy, the probable cost of ownership and management, the degree to which public values are present and require affirmative action to preserve, and the record of similar lands in the region already passed to private ownership.

That there should be marked differences in size of unit between highly productive irrigated lands and range lands is obvious. The danger of attempting to set up large units of range lands when all of the better lands and many million acres of poor land have gone into private ownership is that it will lead to exactly the same kind of maladjustments that have repeatedly occurred under the existing laws.

About genuine land classification as a prerequisite there can be no question, but beyond that much more intensive study is needed as a basis for any thoroughly satisfactory recommendations.

This legislation is desirable but not immediately urgent.

PROBLEMS IN FEDERAL ASSISTANCE TO PRIVATE OWNERS

A group of problems involves various existing programs of the Federal Government in the field of assistance to private owners.

PROBLEMS OF STRENGTHENING THE ATTENTION OF RESEARCH AGENCIES TO PROBLEMS OF RANGE LANDS AND OF THE RANGE LIVESTOCK INDUSTRIES

The State agricultural colleges and experiment stations and the forest and range experiment stations of the Forest Service have under way research projects in the field of range and livestock management. But the program as a whole is seriously inadequate to meet genuine needs.

Recommended legislation.—Insofar as the national range research program is concerned, no basic legislation is needed except on the watershed phase.

THE PROBLEM OF EXTENSION—MAKING THE RESULTS OF RESEARCH MORE READILY AVAILABLE TO LIVESTOCK OPERATORS

The information obtained through the range research programs should be of great advantage to range livestock operators. But systematic public effort to make facts readily available and in most usable form is required. The previous effort in extension has not met this need, since extension work in most of the States has been

devoted primarily to needs of crop agriculture. Full-time range specialists are needed.

Recommended legislation.—An annual program to effectuate plans to place extension work on an adequate basis is immediately desirable.

THE PROBLEM OF CREDITS

The existing Federal credit structure—Farm Credit Administration, intermediate credit banks, and other corporations—is designed to meet the credit needs of all agriculture, including the range livestock business. This report has made no attempt to determine whether the existing machinery and its operations are fully adapted to the requirements of the livestock industry. Any legislation affecting the purely banking features of the existing structures should be initiated by and follow the recommendations of the Farm Credit Administration. It is, however, highly desirable that, if constitutional, the law should recognize as a contractual quid pro quo the general policy that loans will be made only on a basis of conservative use of lands, and that failure of the borrower to follow obt agreements will be cause for cancelation of loans.

The ruling of the Supreme Court that control of agriculture by the Federal Government is unconstitutional may possibly prevent such a program because of the unconstitutionality of the essential requirement that the landowner be required to practice good range management in order to be eligible for Federal assistance. Nevertheless, since the true collateral for long-term loans is perpetual productivity of land, the necessary provisions to insure this are clearly an indispensable feature of sound banking practice.

This study has reached no conclusions as to immediate need for revision of farm-credit laws.

PROBLEM OF MARKETING

Public aid in marketing has thus far taken the form of commitment to the principles of cooperative marketing, construction of better highways, agricultural extension, studies of freight rates, market differentials, price fluctuations, regional livestock production, and prevention of price lowering and excessive service charges at terminal livestock markets.

This study has reached no conclusion as to possible increase in lines of public assistance already undertaken or as to possible new means of assistance.

PROBLEM OF PRODUCTION CONTROL

This study has not attempted to determine the need for control of production from the standpoint of consumptive needs, or lack of it, since the entire field has been covered by the Agricultural Adjustment Administration and the Bureau of Agricultural Economics of the Department of Agriculture. Nor has the study dealt with the question of whether or not any particular formula for production control is an effective one. The attempt at control through the Agricultural Adjustment Administration has been stopped by the

Supreme Court ruling already mentioned. What the public may be able to do remains to be seen, but it seems likely that control of production in some form has come to stay. Its name may change; legal necessity has changed its form and may do so again; but the loss of most of the export market has made permanent the essential need of avoiding unmanageable surpluses.

Recommended legislation.—Thus, whether production control is needed and, if so, what formula should be employed, are questions for appropriate agencies of the Department of Agriculture.

As in the case of Federal credits, it is highly desirable that any form of production control should carry as a contractual quid pro quo provision that conservative land use will be practiced, following recommendation of competent agencies in the Department of Agriculture.

This study has developed no conclusions as to immediate need for additional legislation.

THE PROBLEM OF MANAGING WILDLIFE ON FEDERAL LANDS

The key to development of wildlife is the maintenance of an essentially natural environment; and the key to management is to handle wildlife as a crop, coordinated with all other resources of the land. To a high degree management as a function of landownership is the natural method of approach.

Reliance has been placed on State laws, controlling seasons, bag limits, etc., and on cooperation between States and Federal Government on lands managed by the latter. The ultimate limits of this method are set by the degree to which the past legalistic means of State control are altered to conform to the concept of wildlife as a crop and as a product of environment. Such changes are under way in a few States.

When on a biologically sound basis cooperation is both effective and desirable and the full possibilities should be more fully explored. But where the pattern of management in a State proves inadequate to meet the opportunity for constructive wildlife management on Federal properties, means of action, applied directly by the Federal Government, should be developed.

Problems Requiring State Legislative Action

Earlier sections of the report have also isolated a group of problems requiring State legislative action for their solution.

The problems are:

WHETHER TO DISPOSE OF OR RETAIN RANGE LANDS NOW IN OR TO BE IN STATE OWNERSHIP

Present practice varies in different States, but generally aims to dispose of State lands through sale to private owners—a plan of action implicit if not always legally established in Federal laws granting the lands to the several States. The general effect of the Federal-grant laws is often to encourage handling the lands for maximum revenue; that is, on a real-estate basis. The States in following this

course have, in general, fulfilled Federal requirements rather than selected a course of their own. Since many, if not most, such lands remaining in State ownership are low grade, the disposal policy tends to add to the problem of privately owned lands. Moreover, sale prices are often set by State laws, and in some cases by Federal-grant laws, at a point above their true earning capacity.

Recommended legislation.—Federal legislation which sets or implies a policy of general disposal to private ownership should be repealed in order to afford the States a clean-cut opportunity to retain their lands and place them under professional management.

Beyond that point it is desirable that each range State should decide by State law or constitutional amendment that range lands, including those obtained through Federal grants, through foreclosure of farm loans, and through tax reversion, are to be retained and managed, unless clearly suitable for private ownership. In the event that a State elects to dispose of range lands suitable only for public ownership, it is desirable that the law set as a guiding policy the transfer through sale or otherwise of the lands to other public ownership rather than to pass them to private ownership.

Coupled with this there should be provision that a professional classification of lands be made so that the true place for both private and public ownership may be eventually determined. Legal provision setting excessive sale prices should be modified.

PROGRAM OF JURISDICTION OF STATE RANGE LANDS

At present in most States the State range lands are handled by agencies concerned primarily with obtaining an immediate income or with disposal through sale. That long-term constructive technical management is seldom the ruling point of view is evident from the fact that few States utilize the professional competence available in State institutions devoted to agriculture.

Recommended legislation.—It is highly desirable that in States which elect to retain, block up, and manage their range lands a State agency with professional qualifications should be set up and charged with administration of the lands. Basic State law should naturally declare that permanent and constructive management is to be the guiding purpose.

PROBLEM OF TAX DELINQUENCY AND TAX-REVERTED LANDS

In general, existing tax-delinquency laws are based on the premise that only as a last resort will local government assert title for nonpayment of taxes. The assumption is implicit that any lands having once passed to private ownership have thereby proved their fitness for that status; that if local government is compelled to assert title as a means of collecting taxes it is merely a temporary phase of ownership pending prompt sale to a private owner.

The very process of persistent tax delinquency and tax reversion very often indicates with finality that the lands are not adapted to private ownership. The problems, then, are to reorient State law to this point of view, to provide for real land classification, and to create

legal machinery so that prompt assertion of title by local government may be made.

Under existing law in most States title of tax-reverted lands rests in the county, which may not want to retain or manage the lands. A further problem, then, is to make legal provision so that the State may take over from the counties the range lands acquired through tax reversion. Necessarily, as a part of this step, provision should be made so that the State may satisfy the equity of the counties in the lands.

Recommended legislation.—It is highly desirable that State legislation should include—

1. Provision for careful land classification to determine true place for permanent private ownership.
2. Recognition that range lands within areas classified as doubtful for private ownership and tax delinquent for more than about 3 years are destined for public ownership.
3. Machinery for reasonably prompt assertion of title to such lands by counties.
4. Provision that lands so acquired may be passed by counties to State ownership through payment by State to county of a negotiated sum, based on financial equity in lands.

PROBLEMS OF FACILITATING STATE MANAGEMENT

Even after a basic State policy to retain and manage range lands is settled on, and after provision is made for State acquisition of tax-reverted lands, several problems remain. Lands already owned or acquired from the counties are likely to be scattered or blocked up into units that cannot be readily administered. And State lands are likely to lie within national forests or grazing districts where the primary management job rests on the Federal Government. As a first step, decision must be made after consultation with Federal agencies as to spheres of influence of State and Federal Governments.

Recommended legislation.—Then the professional agency set up to manage State range lands should be authorized to exchange or sell lands with or to the Federal Government, to determine boundaries of State range units after consultation with Federal agencies, and, where lands are in neither State nor Federal reservations, to sell to or exchange with private owners.

Conceivably a State might wish to set up a board or commission, similar to the National Forest Reservation Commission, to pass on recommendations of the State officer.

PROBLEMS OF STATE ACQUISITION OF RANGE LANDS THROUGH PURCHASE

Clearly if the States take over primary responsibility for blocking up and managing lands already owned and those acquired through foreclosure and tax reversion, they will have a sizable job. Whether in addition they will wish to embark on a program of purchasing range lands in a way similar to that suggested for the Federal Government is a question that each State will answer for itself.

Bearing on the final decision of individual States will no doubt be such consideration as the size and cost of the range-management

job already undertaken; financial ability to branch out into new fields; whether cooperative relationships with Federal agencies are on a satisfactory basis; and the rate at which the Federal Government is redeeming its responsibility in range-land acquisition.

Despite the undoubted fact that it would seem that most, if not all, the States already have in sight a task of great magnitude in the immediate future, it is highly desirable that an affirmative State acquisition policy and program be inaugurated.

PROBLEM OF FACILITATING PRIVATE RANGE-LAND OWNERSHIP THROUGH REDUCTION OF LOCAL TAXES

Major factors contributing to unstable private ownership of range lands and to tax delinquency and tax reversion are probably the high level of land valuation and taxation and the elaboration of local governments which forces them.

This whole problem is so complex, involving as it does all forms of private property, and is so bound into existing financial commitments of local government, that this study has made no attempt to analyze it. But it remains as a problem and a challenge to the States, as a large part of their share of the public effort to put the institution of private ownership on a more secure foundation than it now has.

PROBLEM OF WILDLIFE MANAGEMENT

At present, jurisdiction over wildlife rests with the States, since no final legal determination of jurisdiction has been made. In most States wildlife is handled under a complex set of specific and detailed laws setting bag limits, seasons, age, and sex limits, manner of taking, and permanently closed refuges. Fish and game authorities of most States enjoy little or no authority to alter the operation of the laws, even though unmistakable need is found to do so. Under such a set-up the virtual extermination of a species is quite possible even with complete law enforcement. State services, moreover, have not generally attracted to their ranks, even in important executive positions, men with professional training in wildlife management. In most States, in short, wildlife is not regarded or managed as a crop. Naturally, then, relatively little effort has been made to find through research fundamental facts on which a biologically sound plan of management might be based.

Recommended legislation.—Highly desirable State legislation would include provision that all officers have professional training in wildlife management, and that a commission be empowered to determine steps for handling game on problem areas, to determine seasons, bag limits, total kill from individual areas, and allotment of hunting privileges, where all applicants cannot be accommodated.

THE PROBLEM OF FACILITATING ORGANIZATION OF GRAZING DISTRICTS BY PRIVATE OWNERS

The most important attempt so far made to facilitate organization by private owners of grazing districts is in Montana. Under the grazing-district law pooling of resources and joint action has

been undertaken, and under the existing conditions of cooperative intent and able leadership, the venture is regarded as highly successful.

Careful study of operations in this large scale experiment is clearly desirable, so that the true field for its application may be fully understood and additional areas determined in which similar action offers a chance to solve problems of bad ownership patterns.

The Joint Problem of State and Federal Governments to Work Cooperatively

The basic job of government in all these respects should be to make public policy and action supplement private effort so that the range resource will contribute permanently and to the highest possible degree to local, regional, and national wealth and stability. In this job there are clearly defined fields which almost automatically assign themselves to one of the three major parties at interest. But there are large sectors, notably the working out of a more efficient and permanent distribution of ownership, in which joint study, agreement, and action are necessary if the whole job of rehabilitating the range resource is to move rapidly.

To obtain cooperation among the several agencies in the entire venture is not primarily a question of law. It is rather one of intent on the part of responsible States and Federal officials to work the problem out systematically, and with recognition of the place of each in the program. Beyond a doubt this can be accomplished if the task is viewed realistically, rather than through the colored glasses of preconceived political or philosophical dogma and theory.

Costs

The task of putting 728 million acres of range land in productive condition, establishing a competent administration on publicly owned lands, and assisting private enterprise to improve and stabilize range industry will involve expenditures by the livestock producer, the States, and the Federal Government. A recapitulation of these estimated expenditures, needed to realize the major objectives of the foregoing proposed programs, will be of advantage here.

If it is recognized that the range resource of the western United States has been badly punished and that the permanency and welfare of the livestock industry is threatened, the next consideration is to be prepared as a national economic necessity to pay the price of adjustment and restoration. The proposed expenditures will ultimately be returned, in part, from the income of the harvested forage, and in part from the indirect benefits which accrue to the national income through established communities and enterprises growing out of a prosperous livestock industry and well-cared for watersheds.

The proposed expenditures fall into four categories—capital investments in improvements, current administrative requirements, public acquisition of land, and research and extension. The estimates are based on the extensive experience of the Forest Service in handling the national forests, and on special surveys conducted on the public domain and on private lands.

The suggested urgency and the rate at which expenditures should be made are indicated. Current expenditures for administration on publicly owned lands cannot be deferred if some degree of real range management is desired. Expenditures for capital investments, although urgently needed, may be logically programed over a period of years; and the same is true for acquisition of lands and research.

The estimates have in each case been made with one consideration predominant—what minimum expenditure will insure the progressive rebuilding of the resource and give the greatest returns in income, benefits, and services. If some of the capital investments are deferred too long, the ultimate cost of the job may increase many-fold and some areas may be permanently and irretrievably lost for forage production, or become a menace to the conservation of stable and favorably conditioned watersheds.

A program for erosion control on range lands has been omitted. The extent and character of the entire job are not fully known, neither have the final methods for control on a large scale been worked out with sufficient accuracy to give the basis for estimates of costs. Other factors will influence the extent of the erosion-control work that should be undertaken. Good range management, revegetation, and rodent control as proposed in the program will all contribute to the reestablishment and building up of the forage cover. Insofar as this is accomplished, the necessity for other erosion-control measures will be in part modified or entirely eliminated.

THE JOB ON FEDERAL LANDS

NATIONAL FORESTS

A total of 1,430,000 cattle and horses and 6,161,000 sheep and goats are grazed on the 82.5 million acres of existing national forests. While the principle of multiple-use management has been applied to the national forests, so that all resources have been given attention, on units where grazing is important or predominant grazing administration has received its proportionate share of allotted funds. But through multiple-use management the cost of grazing administration has been less than if the national forests were handled solely for the forage resource.

For the administration of grazing of domestic livestock on the national forests during the fiscal years 1932 to 1935 an average expenditure of $0.0089 per acre was incurred. In 1930 an exhaustive study of national-forest work was made, in which it was shown that 38.4 percent of the total work load on the western national forests should be allocated to grazing administration and that, with appropriations available at that time, no such allocation was feasible. The Forest Service had long recognized that additional expenditures were required to realize a more adequate administration of this resource. To meet this obligation would add $0.006 per acre to present expenditure. The total cost for adequate range administration is thus $0.0149 per acre for domestic livestock.

The activities of the Forest Service in wildlife management on national forests now average in cost $0.0018 per acre. To carry forward an adequate wildlife program on existing national forests

located in the western range States, additional funds for administration will be needed. Wildlife management is required on approximately 120 million acres, and the present and prospective resource value of wildlife on this area is inordinately large. On the basis of present information an additional annual expenditure of $500,000 is warranted for the next 5-year period, which would make a per-acre cost of about $0.0042. The total cost of administration of the range for domestic livestock and for wildlife will, therefore, reach the figure of $0.0209 per acre.

In addition to these increases in administration, capital investments must be made on the existing national forests if vital interests of dependent communities and the livestock industry are to be protected and for the development of orderly and well-coordinated range use plans.

The major items of capital investment are as given in table 86, together with a recapitulation of additional annual expenditures needed to secure best range use and development of forage on existing forests for a 5-year period. This figure excludes past expenditures for investments and present current expenditures for administration ($0.0140 per acre for domestic livestock and $0.0018 for wildlife).

TABLE 86.—*National-forest ranges: Cost items involved in capital-investment program and estimated additional administrative costs for first 5-year period*

Cost items	Area to be covered	Cost per acre	Period to complete	Total cost	Annual cost for first 5-year period
	Million acres		Years		
Range surveys and development	85.50	$0.0060	5	$513,000	$102,600
Range fences [1]	28.50	.0088	10	4,370,000	436,000
Water development [2]	32.50	.0407	10	2,963,000	296,000
Artificial revegetation	.70	2.5000	20	2,750,000	138,000
Rodent control	6.00	.0800	5	640,000	128,000
Total capital investment				11,436,000	[3] 1,140,000
Administration (general)	85.50	.0060			500,000
Wildlife management	120.00	.0042			500,000
Maintenance and replacement of improvements	32.50	.0060			[4] 742,000
Total annual cost					2,882,000

[1] 13,300 miles of fence.
[2] 2,500 projects.
[3] Annual cost of capital investments the second 5-year period $910,000.
[4] Annual cost of maintenance and replacement second 5-year period $980,000.

GRAZING DISTRICTS

The net usable public domain and minor Federal reservations available for the creation of grazing districts is estimated at 149.4 million acres. If the public domain is to be adequately administered and developed, and its uses correlated, all the resources requiring management must be given attention. Hence in calculating costs for administration, the development of all the resources has been considered, even though not clearly contemplated under the present grazing act.

A form of organization to administer the public domain with these objectives in view would consist of an independent grazing service with a central unit at Washington and adequate field organization. In the light of the extended experience of the Forest Service, it is estimated that this would cost about $2,260,000 per year or an average of $0.0151 per acre.

To carry forward the proposed wildlife-management program on the public domain, additional costs for such administration must be provided over and above the estimate for general administration. Wildlife management will require at least $150,000 annually or approximately $0.001 per acre to provide for survey, management, and law enforcement.

In addition to these administrative costs, the public domain, if it is to be restored and maintained to its productive capacity, requires outlays in capital investments, as given in table 87.

TABLE 87.—*Public-domain ranges: Cost items involved in capital-investment program and estimated additional administrative costs for first 5-year period*

Cost items	Area to be covered	Cost per acre	Period to complete	Total cost	Annual cost for first 5-year period
	Million acres		*Years*		
Range surveys and development	140.4	$0.0045	5	$608,000	$122,000
Range fences [1]	140.4	.0035	10	4,661,000	466,000
Water development [2]	140.4	.0022	10	3,022,000	302,000
Artificial revegetation	15.0	2.5000	20	45,000,000	2,250,000
Rodent control	40.0	.0800	10	2,200,000	220,000
Total capital investment				57,040,000	[3] 3,360,000
Administration (general)	140.4	.0151			2,260,000
Wildlife management	140.4	.0010			150,000
Maintenance and replacement of improvements	140.4				(4)
Total annual cost					5,910,000

[1] 16,900 miles of fence.
[2] 6,050 projects.
[3] Annual cost of capital investments the second 5-year period, $2,402,000.
[4] None contemplated first 5 years. Annual cost for second 5-year period of maintenance and replacement of improvements built the first 5-year period estimated at $330,000.

INDIAN LANDS

The area of Indian lands in the Western Range States where grazing is carried on is estimated at 48.4 million acres. The present cost of range administration, exclusive of clerical, fiscal, and overhead services, is estimated at $0.005 per acre. In 1936 an increase of $0.006 per acre was estimated as needed in order to obtain more adequate administration of the forage resources, making a proposed total cost of $0.011 per acre. Wildlife management as proposed under the program would add about $0.001 per acre. This would give a cost of $0.012 per acre for range administration of domestic livestock and wildlife.

The estimated capital investment required to preserve, improve, and restore forage and watershed values are given in table 88.

TABLE 88.—*Indian lands: Cost items involved in capital-investment program and estimated additional administrative costs for first 5-year period*

Cost items	Area to be covered	Cost per acre	Period to complete	Total cost	Annual cost for first 5-year period
	Million acres		Years		
Range surveys and development	23.5	$0.0074	5	$210,000	$42,000
Range fences [1]	48.4	.0310	10	1,500,000	150,000
Water development [2]	48.4	.0310	10	1,500,000	150,000
Artificial revegetation	1.6	2.3300	20	4,645,000	232,000
Rodent control	12.0	.0800	5	960,000	192,000
Total capital investment				8,815,000	[3] 766,000
Administration (general)	48.4	.0060			290,000
Wildlife management	48.4	.0010			48,000
Maintenance and replacement of improvements	48.4	.0015			[4] 75,000
Total annual cost					1,179,000

[1] 5,000 miles of fence.
[2] 2,000 projects.
[3] Annual cost of capital investments the second 5-year period $532,000.
[4] Annual cost of maintenance and replacement second 5-year period $222,000.

THE JOB ON STATE AND COUNTY LANDS

State- and county-owned range lands now total 65 million acres in the western range States. If these lands are to be placed under management, provision must be made for a trained professional personnel and investments in primary improvements such as fences, water development, roads, trails, and revegetation. The States and counties will follow forms of organization and administration especially suited to fit in with existing agencies handling conservation and lands in their governmental organizations.

Obviously, it would be difficult to estimate what administrative costs will be with any degree of accuracy. A figure of $0.0116 per acre is estimated as sufficient to inaugurate a reasonably effective organization.

As with the public domain or with national forests, expenditures for basic capital investments must be incurred if State and county range lands are to be built up as permanent sources of forage for livestock production and wildlife and as favorably conditioned watersheds.

Important as the task may be, the States and counties are unlikely for many reasons to embark immediately on any full program. But public recognition that range resources must be preserved may be sufficient to give impetus for States and counties in starting to manage their range lands, within the financial capacities of local governments.

The total capital investments needed for the 65 million acres now in State and county ownership are approximately as follows:

Range surveys and management plans	$345,000
Range fences	8,125,000
Water development	888,000
Artificial revegetation	7,595,000
Rodent control	1,200,000
Total	18,153,000

The annual cost of maintenance and replacement during the second 5-year period will probably amount to $150,000.

If the work is undertaken on a 10-year program, $1,313,000 a year will be required to provide essential basic improvements to place an area of approximately 65 million acres under proper range management. Annual administration will cost $754,000 annually in addition.

THE JOB ON PRIVATE LANDS

Other sections of this report discuss the problems of the private ownership of range lands, the burden of carrying charges, and the probabilities of making capital investments for improvement and restoration.

The necessity for extending public ownership to the submarginal range and farm lands of those now held precariously in private ownership has also been discussed. If all private range lands, 376 million acres, are to be put to best use, restored for forage production and maintained under favorable watershed conditions, the public will undoubtedly have to assume jointly with the private owner the responsibility for development and administration. Three major items of expenditures will be involved in such a program: Purchase of lands, capital investments, and administration.

The magnitude of the problem and the large funds required to carry out a complete and adequate program warrant a deliberate and cautious approach. Nevertheless, unless affirmative action is taken in reasonable time the problem will become more involved and complex and the adverse economic consequences of delay far-reaching. The first and logical step is to conduct a survey of the resources on the land areas involved so as to determine the best plans for management and development and the extent to which public purchase should be undertaken. This will require a survey of at least 215 million acres of privately held land at a cost of about $0.004 per acre.

An area of approximately 125 million acres of submarginal character and high public values has been recommended in an earlier section for ultimate public ownership. Some of these lands will, in all probability, come into public ownership through tax delinquency and some as gifts. Taking these factors into account, an estimate of $1 per acre is set for the cost of acquisition. A 20-year purchase program may be required.

Irrespective of whether private lands remain in private ownership or are in part acquired by the Federal Government and the States, the costs of the investments per acre will be more or less the same.

A rough approximation may be given for expenditures, applicable to the entire area of 376 million acres, during the first 10 years:

Preliminary survey (215 million acres)	$860,000
Fences (19,800 miles)	6,246,000
Water development (10,500 projects)	8,018,000
Artificial revegetation (15 million acres)	48,032,000
Rodent control (75 million acres)	6,000,000
Total	64,156,000

Such a program will require an annual expenditure of $6,416,000. Private owners will carry the bulk of this cost in the form of their own time or that of hired help.

Estimated annual expenditures in connection with the gradual acquisition by the public of 125 million acres over a 20-year period are:

Intensive surveys and management plans	$150,000
Purchase of lands	6,300,000
Total	6,450,000

Administration charges on the publicly acquired lands and to be borne by the public, at $0.015 per acre, would be $94,500 the first year and $945,000 the tenth year. Beginning with the sixth year, the annual cost of maintenance would likely be $200,000.

Assuming that the expense of this entire program would be shared by the public and the private owner about in proportion to the division of ultimate ownership, the annual costs prorated over the first 10-year period would be—

Private owners:	
Capital investments	$4,277,000
Maintenance of these improvements	65,000
Total	4,342,000
Public:	
Capital investments	2,129,000
Purchase and management plans	6,450,000
Maintenance of improvements	35,000
Administration	470,000
Total	9,084,000

Without public assistance it is doubtful, however, if such work as rodent control and revegetation will be undertaken to the extent needed by private owners on the lands to remain in private hands. They may be expected, as their incomes increase and reasonable credit is available, to undertake essential new investments in fences and water developments. Nevertheless, it is probable the public which will have to aid the private owners in carrying out the work so that the ultimate cost to the public may be higher than the annual amount indicated.

A program on the scale indicated would go a long way toward initiating with reasonable aggressiveness the rehabilitation of a vast territory which has suffered through ill-advised marginal farming and destructive range use. The territory in which this program must be started and carried forward presents some of the most vexing submarginal-land-use problems and all the concomitant economic ills which grow out of these. The longer it is put off, the more it will cost.

RESEARCH AND EXTENSION

If the information necessary for effectuating the program of readjustment, administration, and management of range lands is to be available when needed, a more aggressive program for all classes of

research must be undertaken. During the next 10-year period a gradual increase should be made over the current expenditures of about $750,000 until an annual total of $2,750,000 is reached. The Federal Government should assume the responsibility for approximately $2,000,000, the States for $550,000, and other agencies for $200,000.

In order to promote satisfactory management on the 376 million acres of ranges now in private ownership and of privately owned livestock grazing on publicly owned ranges, a range-extension program estimated to cost about $1,000,000 annually should be developed during the next 10 years. This cost should be borne about equally by the Federal Government and the States.

LITERATURE CITED

(1) ANONYMOUS.
1932. SHEEP AND GOAT INDUSTRY IN TEXAS. TEXAS LEADS ALL OTHER STATES IN THE NUMBER OF CATTLE, SHEEP, AND GOATS. Cattleman 18(8): 13–15, illus.

(2) ———
1935. THE GRASSLANDS. Fortune 12(5): 59–67, 185–208, illus.

(3) ———
1935. THE PANHANDLE COMES BACK. Amer. Cattle Producer 17(5): 14.

(4) ABBOT, C. G.
1935. [SOLAR VARIATION AND ITS INFLUENCE ON WEATHER.] Yale Rev. 25(1): 39–41.

(5) ADAMS, HENRY.
1891. HISTORY OF THE UNITED STATES OF AMERICA DURING THE ADMINISTRATION OF THOMAS JEFFERSON. 437 pp. New York.

(6) ADAMS, ROMANZO.
1916. PUBLIC RANGE LANDS—A NEW POLICY NEEDED. Amer. Jour. Sociol. 22: 824–851.

(7) ADAMS, R. L.
1932. MORTGAGE SITUATION WITH SPECIAL REFERENCE TO THE ELEVEN WESTERN STATES. Jour. Farm Econ: 14: 605–614.

(8) AUTEN, J. T.
1933. POROSITY AND WATER ABSORPTION OF FOREST SOILS. Jour. Agr. Research 46: 997–1014, illus.

(9) BAILEY, R. W.
1935. EPICYCLES OF EROSION IN THE VALLEYS OF THE COLORADO PLATEAU PROVINCE. Jour. Geol. 43: 337–355, illus.

(10) ——— FOSSLING, C. L., and BECRAFT, R. J.
1934. FLOODS AND ACCELERATED EROSION IN NORTHERN UTAH. U. S. Dept. Agr. Misc. Pub. 196, 21 pp., illus.

(11) BANCROFT, H. H.
1889. HISTORY OF THE PACIFIC STATES OF NORTH AMERICA. UTAH, 1540–1886. v. 21, illus. San Francisco.

(12) BARNES, W. C.
1913. WESTERN GRAZING GROUNDS AND FOREST RANGES. 339 pp., illus. Chicago.

(13) ———
1914. STOCK-WATERING PLACES ON WESTERN GRAZING LANDS. U. S. Dept. Agr., Farmers' Bull. 592, 27 pp., illus.

(14) ———
1925. THE STORY OF THE RANGE. U. S. Cong. 69th, 1st sess., Hearings on S. Res. 347 before Subcom. of Com. on Pub. Lands and Surveys, pt. 6, pp. 1579–1640, illus.

(15) BEAL, W. H., HAINES, G., HOOKER, W. A., and SCHULTZ, J. I.
1922. RANGE INVESTIGATIONS BY THE EXPERIMENT STATIONS. U. S. Dept. Agr., Off. Expt. Stas., Work and Expenditures of the Agr. Expt. Stas. 1922: 113–126. (Reprinted 1924.)

(16) BENTLEY, H. L.
1898. CATTLE RANGES OF THE SOUTHWEST: A HISTORY OF THE EXHAUSTION OF THE PASTURAGE AND SUGGESTIONS FOR ITS RESTORATION. U. S. Dept. Agr., Farmers' Bull. 72, 32 pp., illus.

(17) BOWMAN, I.
1935. THE LAND OF YOUR POSSESSION. Science 82: 295–298, illus.

(18) BRENNAN, C. A., assisted by FLEMING, C. E., SMITH, G. H., Jr., and BRUCH, M. R.
1935. THE PUBLIC RANGE AND THE LIVESTOCK INDUSTRY OF NEVADA. Nev. Agr. Expt. Sta. Bull. 139, 19 pp., illus.

(19) Bennett, H. H.
1934. The development and decline of open range ranching in the northwest. Miss. Valley Hist. Rev. 20: 521–536.
(20) Bennett, L. J. and Shantz, H. L.
1912. The wilting coefficient for different plants and its indirect determination. U. S. Dept. Agr., Bur. Plant Indus. Bull. 230, 77 pp., illus.
(21) Bennett, J. S.
1881. The beef bonanza . . . being a description of cattle-growing, sheep-farming, horse-raising, and dairying in the west. 332 pp., illus. Philadelphia and London.
(22) Bryan, Kirk.
1925. Date of channel trenching (arroyo cutting) in the arid southwest. Science (n. s.) 62: 338–344.
(23) ———
1928. Historic evidence on changes in the channel of Rio Puerco, a tributary of the Rio Grande in New Mexico. Jour. Geol. 36: 265–282, illus.
(24) Burdick, R. T., Reinhold, M., and Klemmedson, G. S.
1928. Cattle-ranch organization in the mountains of Colorado. Colo. Agr. Expt. Sta. Bull. 342, 62 pp., illus.
(25) ——— Reinhold, M., and Klemmedson, G. S.
1928. A study of ranch organization in eastern Colorado. Colo. Agr. Expt. Sta., Econ. Sec. Bull. 327, 61 pp., illus.
(26) Bureau of Railway Economics.
1930. Livestock, cattle and calves, hogs and sheep. Bur. Ry. Econ. Bull. 38 (Commodity Prices in Their Relation to Transportation Costs Ser.), 12 pp., illus.
(27) Buttrick, P. L.
1926. Forest grazing rights in Europe—some deadly parallels. Jour. Forestry 24: 141–152.
(28) Cameron, Jenks.
1928. The development of governmental forest control in the United States. 471 pp. Baltimore.
(29) Campbell, R. S.
1929. Vegetative succession in the Prosopis sand dunes of southern New Mexico. Ecology 10: 392–396.
(30) ———
1931. Plant succession and grazing capacity on clay soils in southern New Mexico. Jour. Agr. Research 43: 1027–1051, illus.
(31) ———
1935. After the drought. Amer. Cattle Producer 17 (1): 3–5, illus.
(32) Chapline, W. R., and Talbot, M. W.
1926. The use of salt in range management. U. S. Dept. Agr., Dept. Circ. 379, 32 pp., illus.
(33) Clay, J.
1924. My life on the range. 366 pp., illus. Chicago.
(34) Clements, F. E.
1934. The relict method in dynamic ecology. Jour. Ecology 22: 39–68, illus.
(35) Committee on the Conservation and Administration of the Public Domain (James R. Garfield, chairman).
1931. Report, January 1931, transmitted to the President of the United States in pursuance of the act of April 10, 1930. 85 pp., illus.
(36) Connor, L. G.
1921. A brief history of the sheep industry in the United States. Amer. Hist. Assoc. Ann. Rept. (1919) 1: 89–197, illus.
(37) Coues, Elliott.
1893. History of the Expedition under the command of Lewis and Clark. New ed., 4 v. New York.
(38) Coville, F. V.
1898. Forest growth and sheep grazing in the Cascade Mountains of Oregon. U. S. Dept. Agr., Div. Forestry Bull. 15, 54 pp.
(39) Cronemiller, F. P., Jr.
1928. Salting on the open range. West. Cattle Markets and News 2(41): 5–6, 20, illus.

(40) DALE, E. E.
1930. THE RANGE CATTLE INDUSTRY. 216 pp., illus. Norman, Okla.

(41) DARLING, J. N.
1935. THE WILDLIFE SITUATION IN THE U. S. AND ITS REMEDIES. Amer. Game 24 (1): 4, 12–13.

(42) DAVY, J. B.
1902. STOCK RANGES OF NORTHWESTERN CALIFORNIA; NOTES ON THE GRASSES AND FORAGE PLANTS AND RANGE CONDITIONS. U. S. Dept. Agr., Bur. Plant Indus. Bull. 12, 81 pp., illus.

(43) DOUGLASS, A. E.
1919 and 1928. CLIMATIC CYCLES AND TREE-GROWTH; A STUDY OF THE ANNUAL RINGS OF TREES IN RELATION TO CLIMATE AND SOLAR ACTIVITY. 2 v., illus. (Carnegie Inst. Wash. Pub. 289.)

(44) DULEY, F. L., and MILLER, M. F.
1923. EROSION AND SURFACE RUN-OFF UNDER DIFFERENT SOIL CONDITIONS. Mo. Agr. Expt. Sta. Research Bull. 63, 50 pp.

(45) EATON, E. C.
1935. FLOOD AND EROSION CONTROL PROBLEMS AND THEIR SOLUTION. Amer. Soc. Civ. Engin. Proc. 61: 1021–1040.

(46) EMPLEN, A. C., PETERSON, W., CARDON, P. V., STEWART, G., and IVERSEN, K. C.
1923. SHEEP RANCHING IN UTAH. Utah Agr. Expt. Sta. Bull. 204, 60 pp., illus.

(47) FAIRCHILD, F. R., and associates.
1935. FOREST TAXATION IN THE UNITED STATES. U. S. Dept. Agr. Misc. Pub. 218, 681 pp., illus.

(48) FLEMMING, C. E.
1922. ONE-NIGHT CAMPS VERSUS ESTABLISHED BED-GROUNDS ON NEVADA SHEEP RANGES. Nev. Agr. Expt. Sta. Bull. 103, 21 pp., illus.

(49) FLETCHER, R. S.
1929. THE END OF THE OPEN RANGE IN EASTERN MONTANA. Miss. Valley Hist. Rev. 16: 188–211.

(50) FORSLING, C. L.
1924. SAVING LIVESTOCK FROM STARVATION ON SOUTHWESTERN RANGES. U. S. Dept. Agr., Farmers' Bull. 1428, 22 pp., illus.

(51) ———
1931. A STUDY OF THE INFLUENCE OF HERBACEOUS PLANT COVER ON SURFACE RUN-OFF AND SOIL EROSION IN RELATION TO GRAZING ON THE WASATCH PLATEAU IN UTAH. U. S. Dept. Agr. Tech. Bull. 220, 72 pp., illus.

(52) ——— and DAYTON, W. A.
1931. ARTIFICIAL RESEEDING ON WESTERN MOUNTAIN RANGE LANDS. U. S. Dept. Agr. Circ. 178, 48 pp., illus.

(53) ——— and STORM, E. V.
1929. THE UTILIZATION OF BROWSE FORAGE AS SUMMER RANGE FOR CATTLE IN SOUTHWESTERN UTAH. U. S. Dept. Agr. Circ. 62, 30 pp., illus.

(54) FORTIER, S., and BLANEY, H. F.
1928. SILT IN THE COLORADO RIVER AND ITS RELATION TO IRRIGATION. U. S. Dept. Agr. Tech. Bull. 67, 94 pp., illus.

(55) FRÉMONT, J. C.
1845. REPORT OF THE EXPLORING EXPEDITION TO THE ROCKY MOUNTAINS IN THE YEAR 1842, AND TO OREGON AND NORTHERN CALIFORNIA IN THE YEARS 1843–44. 583 pp., illus. Washington, D. C.

(56) GARRETSON, M. S., comp.
1934. AMERICAN BISON SOCIETY CENSUS, 1934. 8 pp. New York.

(57) GASS, PATRICK.
[1847.] LEWIS AND CLARK'S JOURNAL TO THE ROCKY MOUNTAINS IN THE YEARS 1804, –5, –6, AS RELATED BY PATRICK GASS, ONE OF THE OFFICERS IN THE EXPEDITION. (Ed. by James Kendall Hosmer, 1904.) 238 pp., illus. Dayton, Ohio.

(58) GORDON, CLARENCE, GORDON, C. W., McCOY, J. G., BROOKS, T. B., ELLISON, T. W., MOSS, W. M., and others.
1883. REPORT ON CATTLE, SHEEP, AND SWINE, SUPPLEMENTARY TO ENUMERATION OF LIVE STOCK ON FARMS IN 1880. U. S. Dept. Int., Census Office, Tenth Rept., v. 3, pp. 963–1116.

(59) GRANT, U. S.
1877. [SEVENTH ANNUAL MESSAGE TO CONGRESS, DECEMBER 7, 1875.] Cong. Rec. 5 (pt. 1): 31–33.

(60) GRAVES, H. S.
1918. REPORT OF THE FORESTER, 1918. U. S. Dept. Agr., 36 pp.

(61) GRAY, L. C.
1934. LONG-PERIOD FLUCTUATIONS OF SOME METEOROLOGICAL ELEMENTS IN RELATION TO CALIFORNIA FOREST-FIRE PROBLEMS. U. S. Monthly Weather Rev. 62: 231–235, illus.

(62) GREGORY, H. E. and MOORE, R. C.
1931. THE KAIPAROWITS REGION; A GEOGRAPHIC AND GEOLOGIC RECONNAISSANCE OF PARTS OF UTAH AND ARIZONA. U. S. Geol. Survey Prof. Paper 164, 161 pp., illus.

(63) GRIFFITHS, DAVID.
1915. NATIVE PASTURE GRASSES OF THE UNITED STATES. U. S. Dept. Agr. Bull. 201, 52 pp., illus.

(64) GRIGGS, GEORGE.
1930. HISTORY OF MESILLA VALLEY OR THE GADSDEN PURCHASE. 128 pp. Las Cruces, N. Mex.

(65) HANSON, H. C.
1928. EARLY GRAZING RUINS THE RANGES. Cattleman 15(6): 31–32.

(66) HARLAN, C. L.; BURMEISTER, C. A.; and THORNE, G. B.
1933. PRICES, NUMBERS, AND KINDS OF ANIMALS VASTLY CHANGED SINCE THE WAR. U. S. Dept. Agr. Yearbook 1933: 219–230, illus.

(67) HART, G. H. and GUILBERT, H. R.
1928. FACTORS INFLUENCING PERCENTAGE CALF CROPS IN RANGE HERDS. Calif. Agr. Expt. Sta. Bull. 458, 43 pp., illus.

(68) ——— and GUILBERT, H. R.
1933. VITAMIN-A DEFICIENCY AS RELATED TO REPRODUCTION IN RANGE CATTLE. Calif. Agr. Expt. Sta. Bull. 560, 30 pp., illus.

(69) ——— GUILBERT, H. R., and GOSS, H.
1932. SEASONAL CHANGES IN CHEMICAL COMPOSITION OF RANGE FORAGE AND THEIR RELATION TO NUTRITION OF ANIMALS. Calif. Agr. Expt. Sta. Bull. 543, 62 pp., illus.

(70) HASKETT, BERT.
1935. EARLY HISTORY OF THE CATTLE INDUSTRY IN ARIZONA. Ariz. Hist. Rev. 6(4): 3–42.

(71) HAYDEN, F. V.
1877. NINTH ANNUAL REPORT OF THE UNITED STATES GEOLOGICAL AND GEOGRAPHICAL SURVEY OF THE TERRITORIES . . . 1875. 827 pp., illus.

(72) HEDGES, HAROLD.
1928. ECONOMIC ASPECTS OF THE CATTLE INDUSTRY OF THE NEBRASKA SAND HILLS. Nebr. Agr. Expt. Sta. Bull. 231, 42 pp., illus.

(73) HEMPHILL, R. G.
1931. SILTING AND LIFE OF SOUTHWESTERN RESERVOIRS. Amer. Soc. Civ. Engin. Trans. 95: 1060–1072.

(74) HIBBARD, B. H.
1924. A HISTORY OF THE PUBLIC LAND POLICIES. 591 pp., illus. New York.

(75) HOLDEN, W. C.
1930. ALKALI TRAILS OR SOCIAL AND ECONOMIC MOVEMENTS OF THE TEXAS FRONTIER, 1846–1900. 253 pp., illus. Dallas, Tex.

(76) HURST, L. C.
1935. OVERGRAZING INCREASES PRODUCTION COSTS. Amer. Hereford Jour. 26 (9): 58, 60–61, illus.

(77) ISE, JOHN.
1924. THE UNITED STATES FOREST POLICY. 396 pp. New Haven.

(78) JARDINE, J. T.
1915. GRAZING SHEEP ON RANGE WITHOUT WATER. Nat'l Wool Grower 5 (9): 7–10, illus.

(79) ——— and ANDERSON, M.
1919. RANGE MANAGEMENT ON THE NATIONAL FORESTS. U. S. Dept. Agr. Bull. 790, 96 pp., illus.

(80) KALMBACH, E. R.
1934. WESTERN DUCK SICKNESS: A FORM OF BOTULISM. (With bacteriological contributions by Millard F. Gunderson.) U. S. Dept. Agr. Tech. Bull. 411, 82 pp., illus.

(81) KINCER, J. B.
1922. CLIMATE, SEC. A, PRECIPITATION AND HUMIDITY. U. S. Dept. Agr., Off. Farm Mangt., Atlas of Amer. Agr., pt. II, sec. A, 45 pp., illus.

(82) ———.
1928. CLIMATE, SEC. B, TEMPERATURE, SUNSHINE, AND WIND. U. S. Dept. Agr., Bur. Agr. Econ., Atlas of Amer. Agr., pt. II, sec. B, 34 pp., illus.

(83) KIRKEY, J. P.
1930. THE ADMINISTRATION OF INDIAN FORESTS. Jour. Forestry 28: 1041–1062.

(84) LANTOW, J. L.
1929. THE POISONING OF LIVESTOCK BY BRYMARIA PACHYPHYLLA. N. Mex. Agr. Expt. Sta. Bull. 173, 13 pp., illus.

(85) LEOPOLD, ALDO.
1933. GAME MANAGEMENT. 481 pp., illus. New York and London.

(86) LOWDERMILK, W. C.
1930. INFLUENCE OF FOREST LITTER ON RUN-OFF, PERCOLATION, AND EROSION. Jour. Forestry 28: 474–491.

(87) MCKITRICK, REUBEN.
1918. THE PUBLIC LAND SYSTEM OF TEXAS, 1823–1910. Wis. Univ. Bull. 905, 172 pp.

(88) MERRIAM, C. H.
1902. THE PRAIRIE DOG OF THE GREAT PLAINS. U. S. Dept. Agr. Yearbook 1901: 257–270, illus.

(89) METER, W. H.
1924. GROWTH IN SELECTIVELY CUT PONDEROSA PINE FORESTS OF THE PACIFIC NORTHWEST. U. S. Dept. Agr. Tech. Bull. 407, 64 pp., illus.

(90) MUCK, L., MELIS, P. E., and NYCE, G. M.
1932. AN ECONOMIC SURVEY OF THE RANGE RESOURCES AND GRAZING ACTIVITIES ON INDIAN RESERVATIONS. Survey of Conditions of the Indians in the United States, Hearings before a subcommittee of the Committee on Indian Affairs, U. S. Cong. 71st, 2d sess. . . . pt. 22, Grazing on Indian Lands, pp. 12248–12310, illus.

(91) NATIONAL ACADEMY OF SCIENCES.
1896. REPORT OF THE COMMISSION APPOINTED BY THE NATIONAL ACADEMY OF SCIENCES UPON A FORESTRY POLICY FOR THE FORESTED LANDS OF THE UNITED STATES. U. S. Cong., 55th, 2d sess., Senate Doc. 87: 29–65.

(92) NELSON, EDWARD W.
1925. STATUS OF THE PRONGHORNED ANTELOPE, 1922–1924. U. S. Dept. Agr. Bull. 1346, 64 pp., illus.

(93) NELSON, ENOCH W.
1934. THE INFLUENCE OF PRECIPITATION AND GRAZING UPON BLACK GRAMA GRASS RANGE. U. S. Dept. Agr. Tech. Bull. 409, 52 pp., illus.

(94) NEWELL, F. H.
1906. IRRIGATION IN THE UNITED STATES. Rev. ed., 488 pp., illus. New York.

(95) NEW YORK ZOOLOGICAL SOCIETY.
1932. CENSUS OF THE PRONGHORN. N. Y. Zool. Soc. Bull. 35: 185–187.

(96) OLMSTEAD, F. H.
1919. GILA RIVER FLOOD CONTROL. U. S. Cong. 65th, 3d sess., Senate Doc. 490, 94 pp.

(97) ORR, J. B.
1929. MINERALS IN PASTURES AND THEIR RELATION TO ANIMAL NUTRITION. 150 pp. London.

(98) OSGOOD, E. S.
1929. THE DAY OF THE CATTLEMAN. 283 pp., illus. Minneapolis.

(99) Pack, V. V., Collier, G. W., and Klemmedson, G. S.
1923. Ranch organization and methods of livestock production in the southwest. U. S. Dept. Agr. Tech. Bull. 68, 104 pp., illus.
(100) Paxson, F. L.
1924. History of the American frontier, 1763–1893. 598 pp., illus. Boston and New York.
(101) Perkins, J. E.
1863. Sheep husbandry in California: a paper presented before the California State Agricultural Society. 15 pp. San Francisco.
(102) Peret, E. L.
1930. What is the aim of game management? Jour. Forestry 28: 632–636.
(103) Peterson, W., Carbon, P. V., Ikeler, K. C., Stewart, G., and Esplin, A. C.
1927. Cattle ranching in Utah. Utah Agr. Expt. Sta. Bull. 203, 56 pp.
(104) Pickford, G. D.
1932. The influence of continued heavy grazing and of promiscuous burning on spring-fall ranges in Utah. Ecology 13: 159–171, illus.
(105) Potter, E. L.
1925. Cost of producing beef on the ranges of eastern Oregon. Oreg. Agr. Expt. Sta. Bull. 220, 22 pp., illus.
(106) ——— and Lindgren, H. A.
1925. Cost of producing mutton and wool on eastern Oregon ranges. Oreg. Agr. Expt. Sta. Bull. 219, 18 pp., illus.
(107) Powell, J. W.
1879. Report on the lands of the arid region of the United States with a more detailed account of the lands of Utah. U. S. Cong. 45th, 2d sess., Exec. Doc. 73, 195 pp.
(108) Reynolds, R. V. R.
1911. Grazing and floods: a study of conditions in the Manti National Forest, Utah. U. S. Dept. Agr., Forest Serv. Bull. 91, 16 pp., illus.
(109) Richardson, R. N., and Rister, C. C.
1935. The Greater Southwest . . . . 506 pp., illus. Glendale, Calif.
(110) Roberts, P. H.
1930. The Sitgreaves elk herd. Jour. Forestry 28: 655–658.
(111) Roosevelt, Theodore.
1906. [Message to Congress, December 5, 1905.] Cong. Rec. 40 (pt. 1): 91–105.
(112) Russell, I. C.
1902. Geology and water resources of the Snake River plains of Idaho. U. S. Geol. Survey Bull. 199, 192 pp., illus.
(113) Salter, J. C.
1935. Preliminary report on the beaver-trout investigation. Amer. Game 24(1): 6, 13–15.
(114) Sampson, A. W.
1913. Range improvement by deferred and rotation grazing. U. S. Dept. Agr. Bull. 34, 16 pp., illus.
(115) ———
1914. Natural revegetation of range lands based upon growth requirements and life history of the vegetation. Jour. Agr. Research 3: 93–148, illus.
(116) Sampson, A. W., and Malmsten, H. E.
1926. Grazing periods and forage production on the national forests. U. S. Dept. Agr. Bull. 1405, 55 pp., illus.
(117) ——— and Parker, K. W.
1930. St. Johnswort on range lands of California. Calif. Agr. Expt. Sta. Bull. 506, 48 pp., illus.
(118) Sanders, A. H.
1914. The story of the Herefords . . . . 1087 pp., illus. Chicago.
(119) Sarvis, J. T.
1926. Effects of different systems and intensities of grazing upon the native vegetation at the Northern Great Plains field station. U. S. Dept. Agr. Bull. 1170, 45 pp., illus.

(120) SAUNDERSON, M. H., and RICHARDS, D. E.
1931. TYPES OF RANCHES AND OPERATING PRACTICES IN RELATION TO COSTS, INVESTMENT, AND INCOME IN THE RANGE SHEEP CATTLE INDUSTRY OF MONTANA. Mont. Agr. Expt. Sta. Bull. 244, 20 pp., illus.
(121) ——— and VINKE, L.
1935. THE ECONOMICS OF RANGE SHEEP PRODUCTION IN MONTANA. Mont. Agr. Expt. Sta. Bull. 302, 56 pp., illus.
(122) SAVAGE, D. A., and JACOBSON, L. A.
1935. THE KILLING EFFECT OF HEAT AND DROUGHT ON BUFFALO GRASS AND BLUE GRAMA GRASS AT HAYS, KANSAS. Jour. Amer. Soc. Agron. 27: 566–582, illus.
(123) SCHMIDT, H.
1924. FIELD AND LABORATORY NOTES ON A FATAL DISEASE OF CATTLE OCCURRING ON THE COASTAL PLAINS OF TEXAS. Tex. Agr. Expt. Sta. Bull. 319, 32 pp., illus.
(124) SEMPLE, E. C.
1931. GEOGRAPHY OF THE MEDITERRANEAN REGION. 737 pp., illus. New York.
(125) SHANTZ, H. L.
1911. NATURAL VEGETATION AS AN INDICATOR OF THE CAPABILITIES OF LAND FOR CROP PRODUCTION IN THE GREAT PLAINS AREA. U. S. Dept. Agr., Bur. Plant Indus. Bull. 201, 100 pp., illus.
(126) ——— and PIEMEISEL, L. N.
1927. THE WATER REQUIREMENTS OF PLANTS AT AKRON, COLO. Jour. Agr. Research 34: 1093–1190, illus.
(127) SHOEMAKER, D. A.
1930. THE PECOS ELK HERD. Jour. Forestry 28: 648–654.
(128) SHOW, S. B., and KOTOK, E. I.
1924. THE ROLE OF FIRE IN THE CALIFORNIA PINE FORESTS. U. S. Dept. Agr. Bull. 1294, 80 pp., illus.
(129) ——— and KOTOK, E. I.
1925. FIRE AND THE FOREST. U. S. Dept. Agr., Dept. Circ. 358, 20 pp., illus.
(130) SKINNER, M. P.
1929. WHITE-TAILED DEER FORMERLY IN THE YELLOWSTONE PARK. Jour. Mammal. 10 (2): 101–115, illus.
(131) SMITH, J. G.
1893. THE GRASSES OF THE SAND HILLS OF NORTHERN NEBRASKA. Nebr. State Bd. Agr. Ann. Rept. 1892: 280–201.
(132) SMITH, J. R.
1930. INDUSTRIAL AND COMMERCIAL GEOGRAPHY. 959 pp., illus. New York.
(133) SPENCER, D. A., HALL, M. C., MARSH, C. D., COTTON, J. S., GIBBONS, C. E., STINE, O. C., and others.
1924. THE SHEEP INDUSTRY. U. S. Dept. Agr. Yearbook 1923: 229–310, illus.
(134) STEINEL, A. T., and WORKING, D. W.
1926. HISTORY OF AGRICULTURE IN COLORADO, 1858 TO 1926. 659 pp., illus. Fort Collins, Colo.
(135) STEWART, GEORGE.
1926. ALFALFA-GROWING IN THE UNITED STATES AND CANADA. 517 pp., illus. New York.
(136) ———
1935. PLANT COVER AND FORAGE CONDITIONS ON SPRING-FALL AND WINTER RANGES, LARGELY ON PUBLIC DOMAIN LANDS IN THE INTERMOUNTAIN REGION. Utah Agr. Col., Utah Juniper 6: 9–13, illus.
(137) ——— and PITTMAN, D. W.
1931. TWENTY YEARS OF ROTATION AND MANURING EXPERIMENTS AT LOGAN, UTAH. Utah Agr. Expt. Sta. Bull. 228, 31 pp.
(138) STUART, GRANVILLE.
1925. FORTY YEARS ON THE FRONTIER. . . . (Ed. by Paul C. Phillips.) 2 v., illus. Cleveland, Ohio.
(139) TALBOT, M. W.
1926. RANGE WATERING PLACES IN THE SOUTHWEST. U. S. Dept. Agr. Bull. 1358, 44 pp., illus.

(140) TAYLOR, T. U.
1930. SILTING OF RESERVOIRS. Tex. Univ. Bull. 3025, 109 pp., illus.
(141) TAYLOR, W. P.
1930. RESEARCH AS A BASIS FOR WILD-LIFE MANAGEMENT IN THE SOUTH-WESTERN UNITED STATES. Jour. Forestry 28: 637-643.
(142) TEXAS GENERAL LAND OFFICE.
1932. REPORT OF THE COMMISSIONER. . . . 1930-32. 22 pp.
(143) THORNBER, J. J.
1906. ALFILARIA, ERODIUM CICUTARIUM, AS A FORAGE PLANT IN ARIZONA. Ariz. Agr. Expt. Sta. Bull. 52, 58 pp., illus.
(144) ———
1910. THE GRAZING RANGES OF ARIZONA. Ariz. Agr. Expt. Sta. Bull. 65, 360 pp., illus.
(145) UNITED STATES CONGRESS.
1891. WATERSHED OF THE RAINIER FORAST RESERVE, WASHINGTON. U. S. Cong. 57th, 1st sess., Senate Doc. 405, 21 pp.
(146) ———
1905. REPORT OF THE PUBLIC LANDS COMMISSION, WITH APPENDIX. U. S. Cong. 58th, 3d sess., Senate Doc. 189, 373 pp., illus.
(147) ———
1925. NORTHERN PACIFIC LAND GRANTS. . . . LETTER OF FEBRUARY 9, 1925, FROM HON. JOHN G. SARGENT, ATTORNEY GENERAL OF THE UNITED STATES. U. S. Cong., Hearings before Joint Committee on the Investigation of the Northern Pacific Railroad Land Grants, 1925-28, v. 5, pt. 13, pp. 5485-5507, illus.
(148) ———
1931. PROTECTION OF PALO VERDE VALLEY, CALIF. U. S. Cong. 71st, 3d sess., Hearings before the Committee on Irrigation and Reclamation, 42 pp.
(149) ———
1934. CONSERVATION OF WILDLIFE. U. S. Cong. 73d, 2d sess., Hearings on H. R. 237 before Spec. Com. on Conservation of Wildlife, 320 pp., illus.
(150) ———
1934. TO PROVIDE FOR THE ORDERLY USE, IMPROVEMENT, AND DEVELOPMENT OF THE PUBLIC RANGE. U. S. Cong. 73d, 2d sess., Hearings before the Senate Committee on Public Land Surveys, on H. R. 6462, 218 pp., illus.
(151) ———
1935. FLOOD CONTROL. U. S. Cong. 74th, 1st sess., Hearings before the Committee on Flood Control, 33 pp.
(152) UNITED STATES DEPARTMENT OF AGRICULTURE.
1930-34. CROPS AND MARKETS. v. 7-11.
(153) UNITED STATES DEPARTMENT OF AGRICULTURE, BUREAU OF AGRICULTURAL ECONOMICS.
1935. LIVESTOCK, MEATS, AND WOOL MARKET STATISTICS AND RELATED DATA, 1934. 121 pp.
(154) UNITED STATES DEPARTMENT OF AGRICULTURE, FOREST SERVICE.
1933. A NATIONAL PLAN FOR AMERICAN FORESTRY. 2 v., illus. (U. S. Cong. 73d, 1st sess., Senate Doc. 12.)
(155) UNITED STATES DEPARTMENT OF AGRICULTURE, OFFICE OF EXPERIMENT STATIONS.
1930. CLASSIFIED LIST OF PROJECTS OF THE AGRICULTURAL EXPERIMENT STATIONS, 1930. U. S. Dept. Agr. Misc. Pub. 89, 252 pp.
(156) UNITED STATES DEPARTMENT OF AGRICULTURE, WEATHER BUREAU.
1871-1905. CLIMATIC SUMMARIES OF THE UNITED STATES.
(157) UNITED STATES DEPARTMENT OF COMMERCE, BUREAU OF THE CENSUS.
1931. FIFTEENTH CENSUS OF THE UNITED STATES, 1930: POPULATION, NUMBER AND DISTRIBUTION OF INHABITANTS. 1268 pp., illus.
(158) ———
1932. FIFTEENTH CENSUS OF THE UNITED STATES, 1930: DRAINAGE OF AGRICULTURAL LANDS. 453 pp., illus.
(159) ———
1932. FIFTEENTH CENSUS OF THE UNITED STATES, 1930: IRRIGATION OF AGRICULTURAL LANDS. 481 pp.

(160) UNITED STATES DEPARTMENT OF COMMERCE, BUREAU OF FOREIGN AND DOMESTIC COMMERCE.
1934. STATISTICAL ABSTRACT OF THE UNITED STATES, 1934. 791 pp.
(161) UNITED STATES DEPARTMENT OF THE INTERIOR.
1934. ANNUAL REPORT OF THE SECRETARY OF THE INTERIOR FOR THE FISCAL YEAR ENDED JUNE 30, 1934. 417 pp.
(162) UNITED STATES DEPARTMENT OF THE INTERIOR, GENERAL LAND OFFICE.
1875. ANNUAL REPORT OF THE COMMISSIONER OF THE GENERAL LAND OFFICE FOR THE FISCAL YEAR ENDING JUNE 30, 1875. 487 pp.
(163) ———
1931. ANNUAL REPORT OF THE COMMISSIONER OF THE GENERAL LAND OFFICE TO THE SECRETARY OF THE INTERIOR, 1931. 76 pp.
(164) ———
1932. ANNUAL REPORT OF THE COMMISSIONER OF THE GENERAL LAND OFFICE TO THE SECRETARY OF THE INTERIOR, 1932. 78 pp.
(165) UNITED STATES FEDERAL TRADE COMMISSION.
1920. COST OF GROWING BEEF ANIMALS; COST OF FATTENING CATTLE; COST OF MARKETING LIVESTOCK. Rept. Fed. Trade Comm. on the Meat-Packing Industry, pt. 6, 183 pp., illus.
(166) UNITED STATES TARIFF COMMISSION.
1921. THE WOOL-GROWING INDUSTRY. 592 pp., illus. Washington, D. C.
(167) VANCE, R. B.
1932. HUMAN GEOGRAPHY OF THE SOUTH. 500 pp., illus. Chapel Hill, N. C.
(168) VASS, A. F.
1926. RANGE AND RANCH STUDIES IN WYOMING. Wyo. Agr. Expt. Sta. Bull. 147, 150 pp., illus.
(169) ——— and PEARSON, HARRY.
1927. RANGE SHEEP PRODUCTION ON THE RED DESERT AND ADJOINING AREAS. Wyo. Agr. Expt. Sta. Bull. 156, 87 pp., illus.
(170) ——— and PEARSON, HARRY.
1933. CATTLE PRODUCTION ON WYOMING'S MOUNTAIN VALLEY RANCHES. Wyo. Agr. Expt. Sta. Bull. 197, 125 pp.
(171) VAUGHN, H. W.
1916. TYPES AND MARKET CLASSES OF LIVESTOCK. 448 pp., illus. Columbus, Ohio.
(172) VENEGAS, M.
1758. [A NATURAL AND CIVIL HISTORY OF CALIFORNIA . . .] (Transl. from Spanish.) 2 v., illus.
(173) VOORHIES, E. C., and KOUSHAN, A. B.
1928. ECONOMIC ASPECTS OF THE BEEF CATTLE INDUSTRY. Calif. Agr. Expt. Sta. Bull. 461, 128 pp., illus.
(174) WALKER, A. L., and LANTOW, J. L.
1927. A PRELIMINARY STUDY OF 127 NEW MEXICO RANCHES IN 1925. N. Mex. Agr. Expt. Sta. Bull. 150, 107 pp., illus.
(175) WALLACE, H. A.
1934. NEW FRONTIERS. 314 pp. New York.
(176) WALLACE, S. S., MCCOY, J. G., PATTERSON, F. P., SMITH, T. A., and PAUBIN, J. T.
1884. [LEASING PUBLIC LANDS.] Natl. Conv. Cattlemen Proc. 1: 80–81.
(177) WARREN, G. F., and PEARSON, F. A.
1924. THE AGRICULTURAL SITUATION. ECONOMIC EFFECTS OF FLUCTUATING PRICES. 306 pp., illus. New York and London.
(178) WEAVER, J. E.
1926. ROOT DEVELOPMENT OF FIELD CROPS. 291 pp., illus. New York and London.
(179) ———; STODDART, L. A.; and NOLL, W.
1935. RESPONSE OF THE PRAIRIE TO THE GREAT DROUGHT OF 1934. Ecology 16: 612–629, illus.
(180) WEBB, W. P.
1931. THE GREAT PLAINS. 525 pp., illus. Boston, New York, Chicago, Dallas, Tex., etc.
(181) WEEKS, D.; WIESLANDER, A. E.; and HILL, C. L.
1934. THE UTILIZATION OF EL DORADO COUNTY LAND. Calif. Agr. Expt. Sta. Bull. 572, 115 pp.

(182) WELCH, HOWARD.
1924. SORE CHEWING BY CATTLE. Mont. Agr. Expt. Sta. Circ. 122, 8 pp., illus.
(183) WHITE, J. W., and HOLBEN, J. F.
1925. DEVELOPMENT AND VALUE OF KENTUCKY BLUE-GRASS PASTURES. Pa. Agr. Expt. Sta. Bull. 195, 15 pp.
(184) WIESLANDER, A. E.
1932. TIMBER SURVIVES WHERE MAN MISTREATS. U. S. Dept. Agr., Forest Worker 8 (5): 9-10.
(185) WILCOX, E. V.
1911. THE GRAZING INDUSTRY. Hawaii Agr. Expt. Sta. [unnumbered] Separate, 91 pp., illus.
(186) WILKES, CHARLES.
1845. NARRATIVE OF THE UNITED STATES EXPLORING EXPEDITION DURING THE YEARS 1838, 1839, 1840, 1841, AND 1842. v. 4. Philadelphia.
(187) WILSON, M. L., WILCOX, R. H., KLEMMEDSON, C. S., and PAGE, V. V.
1928. A STUDY OF RANCH ORGANIZATION AND METHODS OF RANGE-CATTLE PRODUCTION IN THE NORTHERN GREAT PLAINS REGION. U. S. Dept. Agr. Tech. Bull. 45, 92 pp., illus.
(188) WINKLER, ERNEST.
1930. BIG GAME IN UTAH. Jour. Forestry 28: 668-674.
(189) WOEHLKE, W. V.
1933. THE BATTLE FOR GRASS. Sat. Evening Post 206 (22): 10-11, illus.

APPENDIX

SOUTHERN FOREST RANGES

By W. G. Wahlenberg, Forester, and E. W. Gemmer, Associate Silviculturist, Southern Forest Experiment Station

Conditions on ranges in the Southern States differ markedly from those found in the West. The South is not usually thought of as an important factor in the livestock industry of the country. However, southern forest-range lands cover an immense territory. Within this wide region there are, roughly, 300 million acres of land, two-thirds of which is in forest of one form or another. Most of this 200 million acres of forest land provides some grazing for livestock. Nearly all of the livestock owned by farmers is handled in small herds and for the most part is allowed to range at large. The industry contributes an important share of the income and subsistence of southern farmers.

The South, as covered in this report, includes the nine States from Virginia to Louisiana and Arkansas and the pine-forested sections of eastern Texas and eastern Oklahoma, as shown in figure 86. It can be divided roughly into four physiographic divisions: (1) The extensive Coastal Plain; (2) the Piedmont; (3) the Mississippi River bottomlands; and (4) the remaining area, including the Appalachian-Ozark highlands, sand hills, silt-loam uplands, prairies, marshes, etc. The Coastal Plain and Piedmont form the major part of the southern forest-range land. On these the predominating soils are sands and sandy loams, overlying more or less impervious clay subsoils.

The climate provides mild winters, hot summers, rainfall usually abundant throughout the year, and long growing seasons. Such a climate is conducive to rapid growth of vegetation.

According to the 1934 agricultural census, the area of crop land on southern farms totaled approximately 64 million acres; pasture land amounted to 44 million acres, divided into plowable, 12 million acres; woodland, 24 million acres; and other, 8 million acres. The forest land under fence and devoted to permanent improved pastures is relatively small—probably not over 20 million acres; the remaining 180 million acres of other forest land is also open forest range.

The early settlers in the South appreciated its possibility as a stock-raising country and the forest ranges have been used to some degree for livestock since the early colonial days. While only a small proportion of the total livestock values in the United States are in the South, the number of packing plants, creameries, and cheese factories there is gradually increasing, and the region may some day become self-sufficient in the production of livestock and livestock products.

Table 89 gives the latest data available (1935) on the number and value of livestock in the South in comparison with the United States as a whole.

TABLE 89.—*Number and value of Nation's livestock on farm and range in the South, as of Jan. 1, 1935* [1]

Type of stock	Proportion of Nation's livestock		Value in relation to total value for Nation	
	Thousands	*Percent*	*Thousand dollars*	*Percent*
Horses and colts	754	6.5	55,064	6
Mules and mule colts	2,171	45	238,646	32
Cattle	7,423	12	111,135	9
Sheep and lambs	976	2	3,806	1.5
Hogs and pigs	6,792	18	35,564	15

[1] Bureau of Agricultural Economics estimates.

These data indicate a total of 18,116,000 head of livestock on open and fenced ranges in the South. This represents 14 percent of the total number and 11 percent of the value for the United States as a whole. That the proportionate value of southern livestock is less than their proportionate number, with the exception of mules, is indicative of the lower quality of animals produced in this section of the United States.

FORAGE, FEED, AND RANGE RESOURCES

The principal southern forest range is in the longleaf-slash pine type extending through the lower South, near the seaboard (see map). It consists of large openings in the heavily cut virgin timber stands and typically open grass-covered areas in much of the second-growth forest and embraces altogether about 55 million acres.

The next most important type coincides with the extensive loblolly-shortleaf-hardwood forest of the upper Coastal Plain and Piedmont region, covering approximately 80 million acres of forest land. This forest is usually denser than the longleaf-slash forest and has less forage available.

Other southern forest types that contribute to open range grazing include the bottomland hardwoods (30 million acres) and the upland hardwood forests (35 million acres). The hardwood bottomlands in the Mississippi and other river valleys are more heavily forested than the pine country and support little grass but considerable browse. Switch cane stands, formerly quite abundant here, afford excellent winter feed, but have been greatly reduced by overgrazing and fire. "Paille finne" grass in the bottom lands of the Delta is used for summer grazing and is attracting attention because of its high forage value. It occurs most abundantly on lands where the water level is within 2 or 3 feet of the surface. If cut early and while it is still succulent, it makes good hay. Unfortunately the wild variety bears little seed and artificial propagation by vegetative methods is slow and expensive. The upland hardwood types of forest are not heavily stocked, but provide part-time grazing.

The native herbage of the South consists largely of such grasses as the beardgrasses, or "broomsedges" and the three-awns, or "wire-

grasses", augmented with a scattering of switch canes and other broad-bladed grasses and swamp plants. The grazing capacity of such forage during the grazing season (March–October) varies from 5 to 25 acres per animal unit, with the commonly accepted average of 10 acres. The palatability of the native grasses is, in general, rather low, although during the spring excellent grazing is available for a period of about 90 days. The warm, moist climate brings about a rank growth and early maturity of these grasses. The pro-

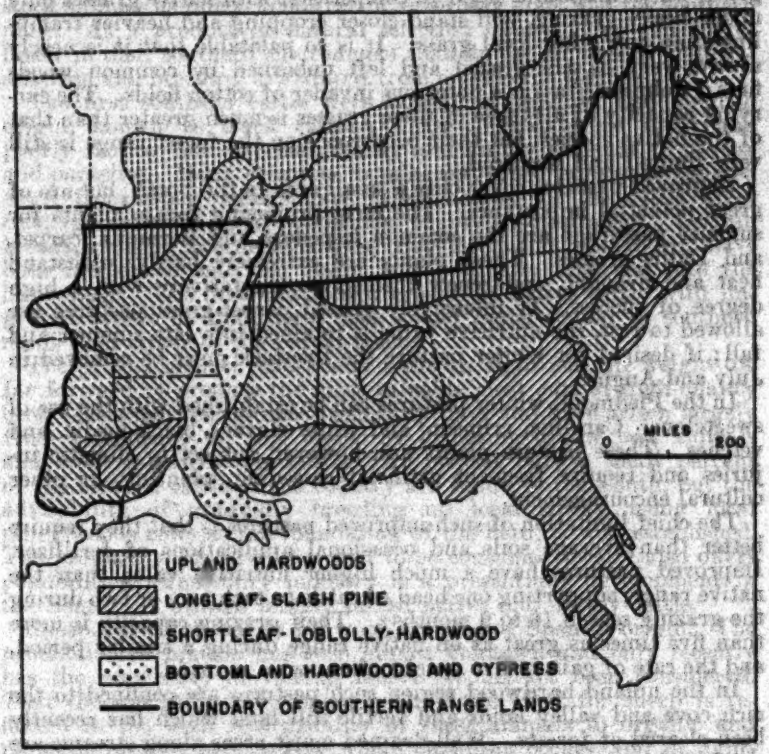

FIGURE 86.—SOUTHERN FOREST RANGES.

Approximately 200 million acres of southern forest range is grazed by domestic livestock which contribute an important share of the income and subsistence of southern farmers.

tein content and hence the nutritive value drops rapidly as maturity approaches, and cattle will not thrive long on this forage alone. The livestock owners customarily burn off every winter the "rough", as this accumulation of dead grasses is locally known, in order that fresh feed may be more easily available to livestock in the spring. This widespread burning is practiced as a rule without regard for the possibility of damage to the forest. Where successive burnings are made at intervals throughout the winter the animals will move progressively over the area, and the period of easily available forage

is thus lengthened. Bottomland plants and broad-leaved grasses supply important winter feed for cattle and deer. Excessive or unregulated burning can jeopardize this food supply.

In addition to native grasses a number of species of grass and legumes which have been introduced and become naturalized in the South have proved to be of high forage value. The most notable are Bermuda, carpet, and Johnson grasses. Bermuda grass is found mainly along roadsides and ditches and in abandoned fields. Carpet grass, which maintains itself in competition with native grasses only under heavy grazing, will stand closer cropping and heavier trampling than any other local grass. It is so palatable that it is nearly always very closely grazed and left unburned by common woods fires. Johnson grass is a notorious invader of cotton fields. The carrying capacity of all three of these grasses is much greater than that of the native species, but their occurrence on the forest range is still very limited and localized.

Improved pastures cover only a small area in the South, but are of great potential importance. The most promising forage plants for summer pasturage are the common lespedeza and Bermuda, carpet, and Dallis grasses. These plants are extremely hardy, withstand heat and drought, and renew themselves vegetatively with a high degree of success. If intensively grazed carpet-grass pastures are allowed to rest, the nutritive value is retained into late summer and fall; if desired for winter pasture the livestock must be removed in July and August.

In the Piedmont, winter pastures can be established with the use of sweetclover, Carolina, crimson, and white clovers, black medic, and vetches. These pasture plants are, however, subject to climatic injuries and require frequent artificial reseeding, planting, or other cultural encouragement.

The chief limitation of such improved pastures is that they require better than average soils and occasional applications of fertilizer. Improved pastures have a much higher nutritive value than the native range, supporting one head of cattle to each acre or two during the grazing season (6 to 9 months). Their grazing capacity is more than five times as great as on native range during a similar period, and the rate of gain in live weight often twice as rapid.

In the upland hardwood region such pastures are confined to the rich cove and valley lands and fertile hill land which has recently been cleared of forests. Well-drained moist areas along streams are the best locations in the Piedmont, while the Coastal Plain region produces its best pastures on low, well-drained soil. In the latter region excellent growth of inkberry or "gallberry" is considered as a good indicator of desirable land for permanent pastures.

After removal of the primary agricultural crop, fenced fields, especially if cultivated, may be used temporarily as pastures. These pastures usually contain a mixture of legumes, weeds, and remains of crop plants such as corn, sugar or ribbon cane, and sorghum, valuable alike to wildlife and domestic animals.

Feeds for winter use can be put up at a very reasonable cost. The production of hay is more difficult in this prevailing moist climate than in the drier regions to the north and west, although the yields per acre compare favorably with those regions. Cowpeas, lespedeza,

and grasses constitute the principal hays. With the invention of the trench silo, the use of sugarcane and sorghum as silage has become more general. Dairy cattle are also fed cottonseed meal, corn, and home-grown or imported grain feeds.

Character of Domestic Animals

Nature has developed in the South such distinct varieties of livestock animals as piney-woods cattle, razorback hogs, and the southern mule. As a product of natural selection they survive and thrive better in their southern environment than do the animals of artificial selection and breeding introduced from outside the region.

The first southern cattle were largely of Spanish and English origin, known as black cattle. These animals were small and poorly shaped, but extremely hardy and highly resistant to disease and parasites. Many attempts to raise and breed pure unacclimated stock from other regions have failed because of the cattle fever tick, ignorance of local conditions, or overcapitalization. Certain breeds, chiefly Aberdeen Angus, Hereford, and Shorthorn, have been introduced into the South and gradually absorbed into the basic stock. The first and second crosses of native cattle with improved breeds of stock have been found better suited to southern needs than either of the parent stocks.

The present typical pine-woods cattle are light and the weight too far forward to produce the most valuable meat cuts of high-quality beef. Such deficiencies date from early days and have arisen largely from a tendency to "top" herds by disposing of the best animals and from excessive inbreeding. At present only a small percent of the blooded cattle of the country are found in the South, but the advisability of gradually breeding up local stocks, using local piney-woods cows as the foundation of the herd, is well established. The production of calves for veal to be consumed locally also offers possibilities. The dairy industry is a present-day development in the South. It utilizes largely mixed native and Jersey cattle.

Sheep, raised primarily for wool, are also of Spanish origin. The production of mutton has been almost unknown and only recently has the possibility of raising lambs for market been considered. That the southern environment is far from ideal for sheep is reflected in the high susceptibility of these animals to organic and parasitic disease, particularly where crowding occurs, and in lightness of fleece. In the South the fleece averages less than 5 pounds in weight, while the average for western sheep is more than 8 pounds. It is estimated that, between 1933 and 1935, screwworms caused a loss of as much as 20 percent of the sheep in portions of the Southeast.

Unlike sheep, hogs have been especially successful in acclimating themselves in the Southern States. Farm hogs benefit from inoculation against cholera and respond well under close management. Essentially a forest animal, the hog has been at home in the pine and oak forests from the very beginning, feeding upon acorns, seeds, grubs, and the succulent roots of pine trees. "The excavating abilities of the pine rooter, a long-nosed beast called 'razorback', are an athletic marvel excelled only by his speed (*132*)." The hogs are

prolific and require practically no attention by the owner except salting or occasional feeding to prevent their wandering too far afield.

In the South, the horse has been developed principally for the saddle or as a light draft animal, while mules have taken the brunt of the heavy farm work. The best mules are produced in the northern part of the region; many are brought in. It is doubtful whether any other animal has been developed which can stand up under the warm climate, disease, and hard work as well as the southern mule.

Wildlife on Southern Ranges

A discussion of grazing on forest ranges would not be complete if confined entirely to domestic stock; wildlife is also a user of the open range. The principle game birds are quail, doves, and turkey; game animals, deer and fox; and the fur bearers include opossum, raccoon, skunk, otter, fox, wildcat, squirrel, and rabbit.[a] To the traditional and widely recognized sentimental and recreational values of wildlife, a variety of commercial values are now being added at many points. The market values of fur and hide are well known, of course. Certain typical cut-over pine lands in the South have been leased for quail-shooting privileges for as much as 15 cents per acre per year. At a value to the user of 30 cents a pound, the dressed carcass of a deer is worth more than that of a native cow raised on the same area. Though not susceptible of precise measurement, the economic value of birds in retarding epidemics of insects is very real.

The greater portion of the forest land in the South is still open to the public for hunting, fishing, and trapping, but private gun clubs and shooting grounds are becoming increasingly popular, along with a demand for more game preserves. Before the white man came extensive areas of the southern "pine barrens" were too uniform, open, and limited in food and hiding places to produce any great amount of wildlife. After the territory was settled increased natural propagation of wildlife resulted indirectly from the numerous widely scattered cleared fields and roadsides where the development of dense patches of hardwoods, bushes, and grass add to the supply of both food and shelter. Many of these trees, shrubs, and plants have previously been regarded as mere weed species. Birds consume many small fruits and seeds found in old fields and in forest openings, especially during periods when insects are not available. As the same openings provide abundant browse and forage for deer, they have multiplied, but in general settlement of the country decreased the supply of the larger animals, while it often increased the numbers of birds and small game.

The possibility of conservation through plan-wise use of wildlife is receiving increased recognition in the South. Investigations, par-

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[a] No census of game has been made for the South as a whole. The following data are indicative, however, of the numbers and values of wildlife in southern forests. The kill in Alabama for the season of 1929–30, as reported by the Department of Game and Fish, was: 2,400,000 quail, valued at $1,200,000; 800 deer, at $20,000; 1,000,000 doves, at $250,000; 615,000 fur bearers, at $2,000,000; and 2,000 turkey, at $20,000. The kill in Texas during the season of 1932–33 was 6,134 deer, 2,183 turkey, and 1,407,836 fur bearers, as given in the Annual Report of the Game, Fish, and Oyster Commission for the fiscal year 1932–33.

ticularly on quail in Georgia, have shown that much can be done to augment game supplies simply through inexpensive measures to bring about favorable changes in natural environment. Much consideration must be given to the most practical means of integrating conflicting interests where the same land is being used for the production of domestic livestock, wildlife, and trees of commercial value. Undoubtedly domestic animals will have to be excluded from areas under intensive management for game, nor can much wildlife be expected to frequent areas intensively used by domestic livestock. Although not affecting game directly, domestic animals are recognized as having an unfavorable influence on many factors which control game animals, such as food supply, disease, parasites, and coverts. The degree of encroachment, however, is proportionate to the numbers of stock, so that in nonintensive range use as in the publicly owned forests, the conflict in requirements of wild and domestic animals is minimized. A practical balance may be attained on superimposed or overlapping ranges, although a more stable and satisfactory cohabitation can be developed where it is possible to segregate the grazing and wildlife projects on more or less separate portions of the managed areas.

Where they are available, the seeds of legumes form a large part of the natural food for quail. Valuable native legumes are increased by a moderate amount of controlled burning which, when properly handled, has been found beneficial to both quail and cattle ranges and is sometimes compatible with timber production. The new spring grass for cattle and subsequently the seeds for the birds are both more readily available on winter-burned areas, whereas summer grazing on native grass is not only unsatisfactory for domestic animals but destructive to quail feed, consisting largely of leguminous seeds.

Where such an increase in game as quail, turkey, and deer is desired, land management should be modified to meet the requirements of game. The following measures are recognized as of outstanding importance in increasing the game populations in the South: (1) Control (or exclusion) of grazing by domestic animals; (2) provision of an adequate food supply, mainly by making openings in the forest, or, under certain conditions, by the controlled use of fire; (3) if necessary, the restocking of favorable habitats by planting imported game species from similar and not too distant places; (4) protection through proper and effective control of hunting and trapping; and (5) the improvement of the environment for wildlife by cultural measures, such as the provision of nesting and hiding places (refuge cover) and the control of predators.

Undesirable Conditions and Range Practices

At least 95 percent of the forest land in the South is privately owned, and much of it is in the hands of large owners who have apparently not shown much or any interest in livestock production. In accordance with age-old custom, southern landowners usually tolerate grazing on their forest lands by the livestock of numerous small farmers. The typical forest range is open, no permits are required, no fees are charged, and often no attempt is made to control

fires set by stock owners to benefit the forage. The ability to survive despite lack of care or cost has allowed the stigma of cheapness to become attached to the southern livestock industry. "This type of farmer expects his stock to cost him nothing and is not disappointed if they yield him little" (*167*). Laws designed to force stock owners to keep animals under fence have been adopted in certain localities, but have not been generally enforced where agricultural crops are of minor value, as is the case in many areas where forest use predominates. It has been regarded as more economical in such cases to fence in the crop land instead of the ranges, thus foregoing the advantages to be had from better control of livestock on the range.

In spite of progressive work by the State agricultural experiment stations and extension services, no widespread interest has been shown in the adoption of improved methods of animal husbandry. Attempts at improvement of the animals through selection and breeding have been sporadic and inconsistently followed. Lack of organization and progressive leadership within the industry to obtain such benefits is a handicap. Enclosed and improved pastures are few in the South. All too often hopeful livestock projects have failed because they were primarily promotion schemes subordinated to some attempted land boom or desperate effort to sell depleted forest lands.

Limited areas of improved pasturage have been created by sodding road shoulders with Bermuda grass, but livestock interests are thus benefited only at the expense of traffic accidents along highways. Ultimately, as the country develops, something must be done to remove rather than aggravate this public hazard.

Economic Trends Affecting Grazing

From the time of the early settlements until the war between the States, and excepting for the periodic business depressions suffered over the entire country, the South enjoyed an almost continuous period of rural expansion and a reasonable degree of prosperity. Primary products have ranged from tobacco, indigo, and cattle, to cotton and timber. The resources, land and wealth, were in the early days largely controlled by a few, while the work was done either by slaves or by the lowest class of white laborers. Exceptions were those people who settled the less productive areas, such as high pine lands, easily eroded hillsides, or remote recesses of the high mountains.

In the production of hides and meat, the southern cattle industry was rather important in the latter half of the eighteenth century and early part of the nineteenth, but declined before the advance of the plantation system, which, based upon the one-crop (cotton) idea, held little place for livestock. More recently, the plantation system has partially broken down through the effects of the boll weevil, soil depletion, and world competition for cotton, and is shrinking back to the inner Coastal Plain and Delta on which it reached its highest development and where it may be maintained. This belt, producing cotton, tobacco, and corn, is deficient in meat and milk products, and this situation offers an opportunity for livestock expansion.

The South has vast areas where an expansion in livestock is possible and desirable. The Piedmont-Appalachian country is capable

of producing ample stocks of dairy products for southern markets, while the Coastal Plain offers opportunities for the production of beef and other meats. The opportunity and need for an expansion in livestock and milk production is being given recognition by the Agricultural Adjustment Administration. The following statements were made recently by two members of the Agricultural Adjustment Administration:

> In the South, the chief recommendations (of the Agricultural Adjustment Administration) are for a decrease in cotton acreage and * * * for increases in total crop land, in pasture land, and in the production of all of the southern feed crops, except corn. These recommended changes are designed to lessen soil depletion and control soil erosion, and to furnish a more adequate feed base for livestock production in the South. As a result, considerable increases are recommended for all classes of livestock * * * (and milk production) * * * chiefly designed for farm consumption. That is, they would be used to improve the standard of living of farmers and farm workers in the South rather than for the commercial market.[a]
>
> Studies of human nutrition indicate that from a dietary standpoint, increases in consumption of dairy products and lean meat, and decreases in consumption of fat meats, are desirable. The shift toward more hay and pasture consumption by livestock, and less feed-grain consumption, would be in the right direction * * *.[b]

Freedom from land taxes and rentals on the range used but not owned and freedom from nearly all investment expenses have afforded a cash income and considerable profit to many southern livestock owners. The annual sale of livestock in the South often brings in the only cash income received during the year, and many bank accounts have been derived wholly from livestock. A great handicap has been and is the lack of the improved pastures that are essential to the most economical production of livestock. Furthermore, in some sections low soil fertility has made pasture development difficult. Pasturage is the cheapest possible form of feed. This is indicated by studies made in 1921 by the Pennsylvania Agricultural Experiment Station (*185*), showing the labor cost per ton of digestible feed to be $21.21 for silage, $15.94 for grain, and $0.66 for pastures. The discovery of an all-purpose grass for the South, such as timothy in the Northeast, that will thrive and produce both hay and permanent pasture, would be a real boon. Nevertheless, unlike much of the livestock in the West, southern livestock can be fattened locally, avoiding shipment to other regions to prepare the animals for market. Although not general practice, it has been demonstrated at some of the southern State agricultural experiment stations that the use of suitable animals and feeds produces meat that compares favorably with western products at the local markets.

A few steps have been taken and definite progress has been made in improving conditions for southern cattle. Most outstanding has been the elimination of the cattle-fever tick from most of the region. The cattle-fever tick area in the United States has been cut down within the past 30 years to less than 9 percent of the area infested when the Department of Agriculture started to drive it out of the

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[a] Wells, O. V. The Regional Adjustment Project: A Summary and Some Suggestions for Further Work. Address before the Association of Land Grant Colleges, at Washington, D. C., Nov. 20, 1935. U. S. Department of Agriculture, Agricultural Adjustment Administration (mimeographed).

[b] Tolley, H. R. Regional Adjustment and Democratic Planning. Address before the Association of Land Grant Colleges, at Washington, D. C., Nov. 20, 1935. U. S. Department of Agriculture, Bureau of Agricultural Economics (mimeographed).

country. On July 1, 1906, when eradication work began, nearly 730,000 square miles in 15 States was under Federal quarantine because of the tick. On December 1, 1935, only a little more than 62,000 square miles remained under quarantine—in Florida, Louisiana, and Texas. This work has removed a discouraging obstacle to the wider use of improved strains in breeding stock, since pure-blooded animals have been particularly susceptible to this disease. Another worthwhile accomplishment has been the development of the dairy industry, particularly in the upper Coastal Plain region. On relatively limited local areas it has brought about the fencing and improvement of pasture lands for controlled and intensive use. An economical trench silo has been developed and superior forage and feed plants introduced in the region through the agricultural experiment stations. On the Coastal Plain in Florida a cooperative colonization scheme, after experiencing the failure of several agricultural crops on rather poor soils, appears now to have established a stable cattle-growing project.

Progressive Steps Needed

As a first requisite in the solution of the range problem, early action should be taken to extend the use of known improvements and to coordinate knowledge already acquired of improved management for livestock, wildlife, and forest products.

Further progress is needed in harmonizing conflicting interests in land use and thus increasing the control of landowners over the use of extensive areas of cut-over timber or range-land managed for such specific purposes as are economically justified. The right of owners to exclude or control range fires on such lands must not only be legally recognized, but also be generally respected, whether the land is to be devoted to the production of timber, livestock, or game animals. Often the various more or less conflicting uses can be advantageously combined. Land-use plans may be expected to provide for varied integrated use of some areas and single segregated use of other areas. Thus commercial grazing may be recognized on certain national forests and only subsistence grazing by local residents may be permitted on other national forests. Domestic livestock may be largely excluded from certain forests, public or private, where game refuges are desired or where grazing interferes with the reproduction of valuable hardwood forest trees. In the latter case it is essential to regulate the grazing, particularly during the stage when the forest area is being reproduced. Whatever the dominant purpose of management may be, adequate control of land use and occupancy is essential to the most successful management. This is particularly true of large areas in the South where such control has not been attained.

Extension of fencing is necessary to effect control of land, and with this extension the known methods of improving pastures, game preserves, and ranges will become more practical as owners will then be able to retain for themselves the benefit of investments in improvements. Similarly the improvement of livestock can then be carried forward more rapidly and consistently. From what is already known, the progress made so far by the livestock industry can be extended materially as soon as the landowner's right to full control is more widely respected. Such wider application of improved

practices will naturally be accompanied by further demands for information that can be obtained only from investigation and research.

A Proposed Program for Range Research

Research on southern forest-range problems calls for coordination in the fields of forestry, range management, animal husbandry, agronomy, and economics. The open-forest range should not be considered by itself, but in conjunction with the development of native and improved pastures.

In forestry the most urgent studies will deal with the following features:

(1) Controlled, periodic, and rotation burning for silvicultural or forest-protection purposes, as related to grazing: This is particularly important for the longleaf-slash pine ranges of the Coastal Plain.

(2) Other silvicultural problems dealing with the conflict of grazing and other forest uses: These problems are more prevalent in the central and northern portions of the region where hardwood species are valuable, and where tree seedlings and soils are particularly susceptible to injury from fires and overgrazing.

(3) Watershed protection: Where erosion results from overgrazing or from burning, the strict regulation or exclusion of grazing and burning is essential.

(4) Forest wildlife relationships: Forest lands are the principal home for wildlife in the South. Forest-land management, including use and control of fire, may have an important bearing on the maintenance of wildlife.

Range management research should cover the following fields:

(1) Determination of relative forage values, at the different seasons, of the important range plants.

(2) Methods of artificial reseeding and improving ranges.

(3) Grazing capacities of various types of ranges.

(4) Systems of range management.

Animal husbandry problems should include:

(1) Feeds and methods of winter feeding.

(2) The production of better livestock by selection and breeding.

(3) The proper care of animals, including such items as dehorning, castration, shelter, bedding, water, salt and mineral nutrients, and particularly the control of disease and parasites such as the screw worm.

Agronomy studies should include:

(1) Agronomic features of artificial reseeding and the development of satisfactory improved and cultivated pastures.

(2) Local production of forage for fall and winter use.

(3) Methods of culture of carpet grass for use on fire lines and old fields.

(4) Improvement of plants for range and pastures through breeding and selection.

In economics there is a need for:

(1) Land classification and surveys including a review of the present status of the livestock industry.

(2) Determination of production costs.

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(3) Range organization and management.
(4) Group financing of improvements.
(5) Cooperative marketing of products.
(6) Part-time forest employment of small stock owners.
(7) Manner and extent of harmonizing the economic aspects of forestry, wildlife, and range uses.

The value of starting such a program in the immediate future becomes more apparent when consideration is given to the social benefits to be expected.

Social and Economic Benefits Attainable

The southern people can be expected to accept changes permitting a gradual rise in their standard of living. A forward-looking program for the development of the southern livestock industry on forest ranges supplemented by improved pastures would benefit the region socially, in the following ways: (1) It would increase the quantity and quality of local food supplies. Meats of better quality and dairy products for more of the people are needed throughout the South. (2) It would increase the cash income of farmers. Already the principal source of income from rural markets to many small owners of livestock, the quality of meat produced locally has yet to be developed to the point where it can reclaim the local urban markets, now dominated by the meat products of other regions. (3) By providing an annual return, landowners would be assisted in meeting the carrying charges for protecting and managing forests and farm woodland. The owners of small tracts of woodland, or the managers of larger forests that have been overcut, can ill afford to neglect this opportunity for additional income from livestock. (4) It would assist in stabilizing agriculture, by promoting the diversification of farm products. Over considerable areas the boll weevil has removed cotton as the money crop, leaving no single successor. Crops of timber and livestock may well take a prominent place in a more stable and diversified agriculture. (5) The improvement and development of the southern livestock industry may be expected to play an important role locally in maintaining communities that are threatened with disintegration as a result of the temporary depletion of timber or failure of cotton as their main source of support.

All of these benefits await the continued intelligent development of the livestock industry on forest ranges and pastures as adapted to local conditions, and as a part of progressive farm and forestry practice.

Additional Literature on Southern Forest Ranges

General

Enochs, F. B.
Experiences in cattle raising on cut-over lands. Proc. Cut-over Land Conf. of the South, pp. 93–96. 1917.

Farley, F. W.
Growth of the beef-cattle industry in the South. U. S. Dept. Agr. Yearbook 1917: 327–340, illus. 1918.

——— and Greene, S. W.
The cut-over pine lands of the South for beef-cattle production. U. S. Dept. Agr. Bull. 827, 51 pp., illus. 1921.

FERRIS, E. B.
DAIRYING ON CUT-OVER PINE LANDS. Miss. Agr. Expt. Sta. Bull. 166, 24 pp., illus. 1918.
FOOTE, F. M.
UTILIZATION OF CUT-OVER LANDS FOR LIVE STOCK. W. Va. Dept. Agr. Bull. 30: 32–35. 1917.
GREENE, S. W.
THE STOCKMAN'S INTEREST IN PROTECTING FOREST AND RANGE FROM FIRE. South. Forestry Cong. Proc. 11: 52–59, illus. 1929.
HEYWARD, F., and BARNETTE, R. M.
EFFECT OF FREQUENT FIRES ON CHEMICAL COMPOSITION OF FOREST SOILS IN THE LONGLEAF PINE REGION. Fla. Agr. Expt. Sta. Bull. 265, 39 pp., illus. 1934.
HOLMES, J. S., and FOSTER, J. H.
CONDITION OF CUT-OVER LONGLEAF PINE LANDS IN MISSISSIPPI. U. S. Dept. Agr., Forest Serv. Circ. 149, 8 pp. 1908.
PERRIN, L. J.
TIMBER AND CATTLE CAN BE RAISED TOGETHER ON SOUTHERN CUT-OVER LAND. U. S. Dept. Agr. Yearbook 1930: 512–514, illus. 1930.
TEMPLETON, G. S.
BEEF CATTLE PRODUCTION IN MISSISSIPPI. Miss. Agr. Expt. Sta. Bull. 268, 31 pp., illus. 1929.
WAHLENBERG, W. G.
EFFECT OF FIRE AND GRAZING ON SOIL PROPERTIES AND NATURAL REPRODUCTION OF LONGLEAF PINE. Jour. Forestry 33: 331–338. 1935.

ECONOMICS

BURMEISTER, C. A., CONWAY, H. M., and BRODELL, A. P.
ECONOMIC FACTORS AFFECTING THE BEEF-CATTLE INDUSTRY OF VIRGINIA. U. S. Dept. Agr. Tech. Bull. 237, 66 pp., illus. 1931.
HOBBS, S. H.
NORTH CAROLINA, ECONOMIC AND SOCIAL. 403 pp., illus. University of North Carolina Press. 1930.
JENNINGS, R. D., and CROSBY, M. A.
AN ECONOMIC STUDY OF LIVESTOCK POSSIBILITIES IN THE SOUTHEASTERN COASTAL PLAIN. U. S. Dept. Agr. Tech. Bull. 127, 96 pp., illus. 1929.
NORTH CAROLINA STATE GEOLOGIST AND STATE FORESTER.
A STATE-WIDE STOCK LAW FOR NORTH CAROLINA. N. C. Geol. and Econ. Survey Press Bull. 97, 3 pp. 1912.
SHEALY, A. L.
BEEF PRODUCTION IN FLORIDA. Fla. Agr. Expt. Sta. Bull. 260, 54 pp., illus. 1933.
VINALL, H. N.
PASTURE IMPROVEMENT THE FIRST NEED IN STRENGTHENING SOUTH'S LIVESTOCK INDUSTRY. U. S. Dept. Agr. Yearbook 1931: 421–424, illus. 1931.

FORAGE

ALDOUS, A. E.
EFFECT OF BURNING ON KANSAS BLUESTEM PASTURES. Kans. Agr. Expt. Sta. Tech. Bull. 38, 65 pp., illus. 1934.
BLAIR, E. C.
LESPEDEZA IN NORTH CAROLINA. N. C. Agr. Col. Ext. Circ. 105, 8 pp., illus. 1923.
——— and KIMREY, A. C.
PASTURES IN NORTH CAROLINA. N. C. Agr. Col. Ext. Circ. 202, 12 pp., illus. 1934.
CAMP, P. D.
A STUDY OF RANGE CATTLE MANAGEMENT IN ALACHUA COUNTY, FLORIDA. Fla. Agr. Expt. Sta. Bull. 248, 28 pp., illus. 1932.
CARRIER, LYMAN, and OAKLEY, R. A.
THE MANAGEMENT OF BLUE-GRASS PASTURES. Va. Agr. Expt. Sta. Bull. 204, 18 pp., illus. 1914.
DUSTMAN, R. B., and VAN LANDINGHAM, A. H.
THE CHEMICAL COMPOSITION OF CONSECUTIVE CUTTINGS OF ANDROPOGON VIRGINICUS AND DANTHONIA SPICATA. Jour. Amer. Soc. Agron. 22(5): 719–724, illus. 1930.

GILBERT, L. D.
TIMBER GROWING AND LIVE STOCK PRODUCTION. South Forestry Cong. Proc. 9: 86–88. 1927.
GREENE, S. W.
PERMANENT PASTURES FOR PINE LANDS. Lumber Trade Jour. 95(2): 24. 1929.
HENSEL, R. L.
EFFECT OF BURNING ON VEGETATION IN KANSAS PASTURES. Jour. Agr. Research 23: 631–643, illus. 1923.
———
RECENT STUDIES ON THE EFFECT OF BURNING ON GRASSLAND VEGETATION. Ecology 4: 183–188, illus. 1923.
ROLFS, P. H.
RHODES GRASS. Fla. Agr. Expt. Sta. Bull. 138: 183–190, illus. 1917.
SCOTT, J. M.
BAHIA GRASS. Fla. Agr. Expt. Sta. Press Bull. 320, 2 pp. 1920.
———
PERMANENT PASTURES FOR FLORIDA. Fla. Dept. Agr. Bull. (n. s.) 27, 46 pp., illus. 1929.
TABOR, P., and ALEXANDER, E. D.
PASTURES FOR GEORGIA. Ga. State Col. Agr. Bull. 389, v. 19, 32 pp., illus. 1930.
THOMPSON, J. B.
CARE AND MAINTENANCE OF THE BERMUDA GRASS PASTURE. Fla. Agr. Expt. Sta. Press Bull. 312, 2 pp. 1919.
———
NAPIER AND MERKER GRASSES—TWO NEW FORAGE CROPS FOR FLORIDA. Fla. Agr. Expt. Sta. Bull. 153: 237–249, illus. 1919.
———
SOME FLORIDA GRASSES. Fla. Univ. Agr. Ext. Bull. 28, 44 pp., illus. 1921.
TRACY, S. M.
FORAGE FOR THE COTTON BELT. U. S. Dept. Agr. Farmers Bull. 1125, 68 pp., illus. 1920.

ANIMALS

BECKER, R. B.; NEAL, W. M.; and SHEALY, A. L.
1. SALT SICK: ITS CAUSE AND PREVENTION. 2. MINERAL SUPPLEMENTS FOR CATTLE. Fla. Agr. Expt. Sta. Bull. 221, 28 pp., illus. 1931.
BLACK, W. H.
FEEDING BEEF CATTLE IN FLORIDA. Fla. Univ. Agr. Expt. Bull. 26, 19 pp. illus. 1920.
DVORACHEK, H. E., and SIMPLE, A. T.
BEEF PRODUCING QUALITIES OF PUREBRED ABERDEEN-ANGUS CATTLE COMPARED WITH ARKANSAS NATIVE CATTLE. Ark. Agr. Expt. Sta. Bull. 247, 19 pp., illus. 1931.
KNAPP, BRADFORD, JR., and SHEALY, A. L.
BEEF CATTLE IMPROVEMENT IN FLORIDA. I. IMPROVEMENT OF BEEF HERDS THROUGH BREEDING. II. A METHOD OF GRADING RANGE BREEDING COWS. Fla. Agr. Expt. Sta. Bull. 281, 22 pp., illus. 1935.
LEFFINGWELL, L. J.
FOREST AND GAME MANAGEMENT IN SOUTH CAROLINA WITH SPECIAL REFERENCE TO GAME BIRDS. Jour. Forestry 31: 658–663. 1933.
LEOPOLD, ALDO.
REPORT ON A GAME SURVEY OF MISSISSIPPI. (Submitted to the Game Restoration Committee, Sporting Arms and Ammunition Manufacturers Institute.) 215 pp., illus. 1929. [Typewritten.]
LEVERETT, H. H., and BUCHANAN, D. S.
SHEEP PRODUCTION IN MISSISSIPPI. Miss. Agr. Expt. Sta. Bull. 260, 36 pp., illus. 1928.
MOHLER, J. R.
IMPROVING CATTLE IN AREAS FREED OF TICKS. U. S. Dept. Agr. Leaflet 33, 8 pp., illus. 1929. (Revised 1933.)
STODDARD, H. L.
THE BOBWHITE QUAIL: ITS HABITS, PRESERVATION, AND INCREASE. 559 pp., illus. New York, Charles Scribner's Sons. 1931.

ALASKA

By B. F. Heintzleman, Principal Forester

In 1867 the United States purchased from Russia the vast territory then known as Russian America but now designated as Alaska. Despite an occupancy covering more than three-fourths of a century, the Russians left the country in much the same condition as they had found it—an unbroken wilderness. General colonization was not fostered and the white population was confined almost exclusively to the officials and employees of the fur company which was the dominant factor in the affairs of the Territory. Operations were confined chiefly to the exploitation of the sea otter and seal of the coastal waters and the upland furbearers of the coastal areas. These activities involved little use or even exploration of the great land mass.

American sovereignty brought no abrupt change. For three decades the white population was inconsiderable, and it was not until the great gold rushes, around the turn of the century, that white men became well dispersed over the country. The placer-mining activity brought many thousands of men into the Territory but the excitement subsided after 10 or 15 years, and the majority of the goldseekers departed. Although gradually increasing for the past 20 years, the present number of inhabitants, white and native, equals only one person to 10 square miles. Most of the population is concentrated in coastal towns and villages and is employed in industrial enterprises involving little land use.

There has thus been no extensive development and use of the available land resources to date. In interior and arctic Alaska, however, the white occupation brought with it continuous devastation by fire of timber, grass, and tundra cover which are needed to support the varied and abundant existing wildlife and to provide a basis for future increased settlement. There has also been some serious deterioration of range lands on portions of the Bering Sea coast through overgrazing by reindeer.

Present conditions in Alaska with respect to the land resources are comparable to those which prevailed in the West 60 or more years ago, before the great tide of western settlement was well under way.

To avoid mistakes similar to those made in connection with the development of the West and to correct existing bad practices, a program of protection and planned use should be initiated at an early date for those extensive public-owned resources of Alaska which have not yet been brought under careful management.

Geographic and Physical Features

Alaska has an area of 586,400 square miles. It is one-fifth the size of continental United States and nearly equals in extent the

Rocky Mountain States of Montana, Wyoming, Colorado, New Mexico, and Arizona. Though it forms the northwest extremity of the North American continent, only one-fourth of its area is north of the Arctic Circle. Its position with regard to latitude is about the same as that of the Scandinavian Peninsula and the town of Seward on the south coast is located on about the same parallel as Oslo, Norway.

The Territory can easily be classified into four geographic divisions (fig. 87), as follows:

Arctic slope.—The Arctic slope includes all lands draining into the Arctic Ocean north of the Seward Peninsula. Its southern limit is the high Brooks Range and some lower mountains to the west which together form the divide between the Yukon and Arctic drainage areas. The topography of the Arctic slope consists of a broad low-lying area along the shores of the Arctic Ocean which is gradually succeeded by rolling ridges and steep slopes as the crest of the Brooks Range is approached. The size of this division is 114,460 square miles.

Interior.—The interior division extends from the Arctic divide on the north to the crest of the Chugach Mountains on the southern coast. It includes the large drainage areas of the Yukon River and Kuskokwim River, the high Alaska Range in the central part of the Territory, and the region between the Alaska Range and the Chugach Mountains which drains south, through breaks in the Chugach divide, to the Pacific Ocean. Aside from the steep slopes of the three mountain ranges mentioned, this region is one of high plateaus, ridges of moderate slope and height, and broad flat valley floors. In the Yukon and Kuskokwim drainages the plateau section gives way, in the western or lower river sections, to the Yukon-Kuskokwim Delta, a very wide strip of marshland across which the two rivers flow to reach Bering Sea. The size of this division is 373,465 square miles.

Southern.—The southern division consists of the coastal strip south of the crest of the Chugach Mountains and west of Meridian 141°, the Alaska Peninsula, Aleutian Islands, and the Kodiak Island group. The mountains extend to the shores of tidewater and the topography is very rough. The area is 62,915 square miles.

Southeastern.—The southeastern division[35] is composed of the narrow strip of mainland and adjacent chain of islands lying east of

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[35] Southeastern Alaska is the most accessible and populous section of the Territory, and appears to offer the best opportunity for an early and material expansion in economic development. Its population in 1930 was 19,204 of which 12,877 were whites and the remainder native Indians. It has dense forests of the western hemlock-Sitka spruce type and the volume of standing timber on the Tongass National Forest is estimated to be 78.5 billion board feet. An important local sawmill industry is located in this region, but the timber resources are primarily valuable as raw material for a prospective pulp and paper manufacturing industry. Under proper forestry practices the timberlands of this region can produce approximately 1,000,000 tons of newsprint paper each year in perpetuity.

The principal existing industries are fishing, mining, and lumbering. The agricultural possibilities are small because of the steep topography, wet weather during the growing season, and the difficulties of clearing the densely forested lands. Home gardens are very productive.

The only extensive open lands consist of wet "muskegs" (peat bogs) within the forest areas, and grass and brush areas above timber line. With few exceptions these lands are more valuable for the support of game animals than domestic stock and will continue to be so used.

Deer and black bear are well distributed and quite numerous. Grizzly bears are found on the mainland areas and the big brown bear on three of the principal islands. A management plan has been provided for the big brown bears on Admiralty Island, one of the three islands indicated above.

The Glacier Bay National Monument of 1,820 square miles is located in this region. Its outstanding feature is a group of tidewater glaciers, but the area is also a bird and wildlife sanctuary.

meridian 141° and extending southeast from the main body of the Territory for 400 miles along the west side of British Columbia. This is strictly a region of rough, rugged topography. The area is 35,500 square miles. This section of the Territory has been included in the Tongass National Forest, the resources of which are now under adequate administration. The forest area is 25,900 square miles.

The present account of Alaskan land resources deals primarily with the main area of the Territory, i. e., with the Arctic, interior, and southern sections and excludes southeastern Alaska.

Figure 87.—Alaska is equal in size to the Rocky Mountain States—Montana, Wyoming, Colorado, New Mexico, and Arizona. With the exception of the 35,500 square miles in the southeastern region, practically all of the Territory is suitable for the use either of wildlife, reindeer, or domestic livestock.

Climate of the Main Area

The Territory has a wide range of climate. Arctic conditions prevail in the extreme north, the interior compares with the prairie Provinces of Canada, and the whole Pacific coastal strip, with its moderate winter temperatures and heavy precipitation, bears a striking climatic resemblance to the coast of British Columbia, Washington, and Oregon. The high range of mountains lying parallel and adjacent to the southern coast blocks progress inland of the warm moisture-laden winds from the Pacific, and consequently interior

Alaska has a light precipitation and the low winter temperature typical of lands of its high latitude.

The Arctic region has a mean temperature of 38° to 45° F. in summer and −16° to −10° F. in winter. The annual precipitation is approximately 6 to 8 inches. Interior Alaska areas have short, warm summers, with mean temperatures ranging from 50° to 58° F., and long winters, with mean temperatures between 0° and −20° F. The annual precipitation is between 7 and 20 inches. In the southern region the mean temperature for summer is between 50° and 55° F., and for winter from 20° to 35° F. The rainfall varies between 50 and 190 inches. Much of the ground in the interior and Arctic regions is permanently frozen to bedrock. In the interior region the surface ordinarily thaws to a depth of 18 to 24 inches during the summer months, but with the removal of the usual dense ground cover of moss the soil gradually becomes free of permanent frost to much greater depths. No permanently frozen ground is found in the Pacific coastal strip.

Permanent icefields and glaciers, though prominent features of Alaska, cover only a small percentage of the land area, and are largely limited to the mountain system along the south coast and to the slopes of the high Alaska Range.

Population

The population in 1930 of the main area of Alaska consisted of 15,763 whites and 24,211 Indians and Eskimos—total, 39,974. The Arctic slope north of Seward Peninsula accounts for 2,857 of the above—118 whites and 2,739 Eskimos.

The number of persons living in towns and villages of more than 250 inhabitants was 12,050 of both races.

The gainful workers of both sexes and all races was 18,201. The principal classes of employment were mining, fishing, trapping, farming (general, fur, reindeer), lumbering, and the service industries supporting the workers in these activities.

Land Status

Title to the lands of Alaska is almost entirely in the Federal Government. Perhaps not to exceed 1 percent of the area has passed to private ownership. Portions of the Federal lands have been withdrawn from private entry under the public-land laws and are administered for specialized purposes, but the greater part of the Territory remains in the status of open public domain.

Following are the principal withdrawn areas[*] on which protection and planned use of the land and its vegetative-cover resources are given consideration:

Chugach National Forest—area, 7,583 square miles—located on the southern coastal strip of the main body of the Territory; held primarily for continuous timber production. All of its resources are given protection and are subject to use under appropriate restrictions.

[*] Excluding southeastern Alaska.

McKinley National Park—area, 3,030 square miles—located on the Alaska Range in interior Alaska; reserved primarily for its scenic features. All of its land and cover resources are given protection. Is a bird and wildlife sanctuary.

Katmai National Monument—area, 4,275 square miles—located on Alaska Peninsula; a bird and wildlife sanctuary; reserved to give protection to its unique physical features.

Aleutian Islands Bird and Wildlife Refuge—covers all of the islands of this chain, including Unimak Island on the extreme east. All forms of bird and wild animal life are protected.

Land and Cover Resources—Their Social and Economic Value

VEGETATION

The narrow strip of country south of the crest of the mountains on the southern coast and west to Cook Inlet is characterized by forests of the type, designated as the coast forest, that occurs as a narrow coastal belt from southern Alaska to Oregon. With this exception the vegetative cover types of the Territory are those which commonly prevail throughout the sub-Arctic and Arctic sections of the North American Continent.

THE COAST FOREST REGION

The western hemlock-Sitka spruce forests are composed of dense stands averaging 15,000 to 20,000 board feet per acre of valuable saw timber. A dense understory of brush, with blueberry predominating, is usually present, and the ground is blanketed with a thick mat of moss. The timber cover is broken at frequent intervals by brush patches and muskegs. The altitudinal limit of tree growth varies between 1,000 and 2,500 feet above sea level. Above these elevations the forest is succeeded by brush, grass, and herbs. The mountain tops, above 4,000 feet, are usually bare. Due to the humid climate of this region, the vegetative cover has suffered little from fire. The sections of this region in which timber predominates are largely included in the Chugach National Forest.

INTERIOR FOREST REGION

The most prevalent type of the so-called interior forest, lying north of the coast forest region, is a mixture of white spruce and Alaska white birch with northern black cottonwood a frequent associate. It occupies the better-drained soils of valley floors, benches, rolling ground, and the lower slopes of the high ridges. Growth is very slow. The white spruce reaches a larger size than the other species but rarely exceeds 18 inches in diameter and 50 to 60 feet in height. The type most frequently occurs as open woodlands. Stands of sufficient density to be classed as forests are common but seldom continuous over extensive areas.

The altitudinal limit of the white spruce-white birch type may be as high as 2,500 feet or more above sea level for the region as a whole, but in many places, because of adverse local conditions, it is much lower.

A second forest type occurs on the wet lowlands. The trees are short and gnarled, rarely exceed 6 inches in diameter, and occur as scattered individuals or in small groups. The predominating species is black spruce, but stunted tamarack, white spruce, and Alaska white birch are frequently present, especially on patches of somewhat better-drained soils.

Open stands of aspen occur on steep, dry slopes and thickets of alder and willow on valley floors.

Both the dense and fairly dense timber areas carry a moderate growth of brush and a deep ground cover of moss and lichens. The open stands of timber have a heavy growth of brush, principally ground birch and alder. The very extensive wet lowlands support dense stands of low willows, other shrubs, lichens, and herbaceous growth. The better drained soils of the river bars and benches are covered with grasses and weeds.

From timber line to elevations between 4,000 and 5,000 feet the cover is composed largely of brush and lichens. The grasses do not occur widely here. This high range is of greater forage value than the range below timber line.

The forest zone of the main area of the Territory extends north to the south slope of the Brooks Range and west to Norton Sound, Bethel on the Kuskokwim River, and the base of the Alaska Peninsula. No satisfactory estimate of the actual acreage within this zone covered with forests is available, but a conservative guess places the extent of the dense and open woodland stands at between 100,000 and 125,000 square miles, or 64 to 80 million acres. The average stand per acre is probably about 7 cords giving an estimated total volume of between 448 million and 560 million cords.

NONFOREST REGIONS

The nonforest sections consist of grasslands and tundra. The principal grassland areas are the Alaska Peninsula, Aleutian Islands, Kodiak Island, and some nearby small island groups. This portion of the southern Alaska coast is beyond the western limits of the western hemlock-Sitka spruce forest and the lower slopes of the prevailing mountainous lands are clothed with a dense, waist-high growth of grass and herbs from tidewater to high elevations. Low-lying lands at the heads of bays carry heavy stands of beach grasses and sedges. Thickets of stunted alders are found in scattered patches in the bottom of ravines and other protected spots.

The tundra area lies to the north and west of the forest region. It includes the vast strip of low-lying land comprising the Kuskokwim-Yukon Delta near the shores of Bering Sea, the rolling lands which constitute Seward Peninsula, and the whole of the Arctic slope.

The tundra cover is composed of sedges, dwarf shrubs, lichens, mosses, weeds, and grasses. Wet and dry tundra are recognized as separate vegetative types based on a difference in the composition of the species but both form a full cover and have high forage value. The rocky ridges have a more open and dwarfed cover. Thickets of tall willow occur along many of the streams, and scattered patches of alder and birch are found in the valleys and on upper slopes.

No surveys have ever been made to determine the extent of the cover types of Alaska. The estimated areas of the zones in which

each of the principal cover types predominates are given below merely as an indication of the area of the types. The estimates do not exclude barren areas within the outside boundaries of the zones.

	Square miles
Western hemlock-Sitka spruce forest zone (west of meridian 141°)	7,500
White spruce, birch forest zone	337,925
Tundra zone	150,000
Alaska Peninsula-Aleutian Island grassland zone	55,415
Total of main area[1]	550,840

The maintenance of the vegetative cover of the forest, grass, and tundra lands is essential to the present and future welfare of Alaska. The social and economic development of the greater part of the Territory, both present and potential, is largely predicated on farming, mining, reindeer grazing, cattle and sheep raising, and the use of the abundant wildlife. The extent to which these activities can be maintained and expanded is dependent in large measure on the protection and proper use of the cover resources.

The agricultural areas are situated in the forested sections and the pioneer Alaska farmer must draw constantly and heavily on the local forests for fuel, building materials, fencing, and many other uses. He also needs grass and browse cover as forage for domestic livestock. The mining industry uses the local forests extensively. In many localities they are the only source of fuel and timber needed in mining operations. The reindeer herdsmen and cattle and sheep raisers are even more dependent than the farmer and miner on the maintenance of the vegetative cover for a livelihood. The prospector, trapper, fur rancher, and, in fact, everyone who is engaged in any outdoor pursuit in this pioneer region is dependent in many ways on one or a number of items comprising the cover resources.

Growth in the interior forest is so slow that even under good protection and management it may fall short of fully supplying the timber needs of the future local population. Little of the interior timber will ever come into the general timber-products markets. Birch trees of the best quality are suitable for cabinet-making and may be removed from some of the more accessible areas, such as around the head of Cook Inlet, for shipment to Pacific Northwest factories. In the distant future some of the more accessible white spruce may be shipped south for pulp manufacture.

Game animals and fur bearers which occupy a highly important place in the economy of Alaska cannot exist without cover. Its value as food supply to the carnivores is indirect in that it is required by the rabbits, rodents, and other small animals on which the carnivores prey.

AGRICULTURE

The existing and potential agricultural areas of Alaska are estimated to be 65,000 square miles. The principal agricultural localities cover portions of the main valleys of the Tanana, Kuskokwim, and Yukon Rivers in the Interior Plateau region, and the Matanuska Valley and the west side of Kenai Peninsula in the vicinity of Cook

[1] Exclusive of southeastern Alaska with 35,500 square miles composed largely of western hemlock-Sitka spruce forest cover.

Inlet. The better agricultural lands usually occur on the low benches and on moderate slopes at the bases of the ridges but occasionally on valley floors. They are not continuous over extensive areas but are broken by patches of little agricultural value.

The crops now being raised consist largely of spring wheat, oats, barley, peas, vetch, potatoes, carrots, and rutabagas. Quickly maturing strains of the three grain crops first mentioned have been developed to meet the climatic conditions of the region. Oats, brome, and vetch are the main hay crops. Dairying is an important feature of farming because of the high local demand for dairy products.

The soil of the coastal strip south of the Chugach Mountains is capable of producing good garden crops but has little value for agriculture owing to the cool, wet weather during the growing season and the expense of land clearing.

The 1930 census showed the total number of farms in the Territory, outside of southeastern Alaska, to be 398 and the improved area of farm land 6,270 acres. The total number of livestock in the region at that time was approximately 6,800 sheep, 1,400 cattle, and 300 horses.

REINDEER GRAZING

Reindeer were introduced into Alaska from Siberia to provide the Eskimos with an additional and more dependable source of food supply than the game and fish on which they had previously and almost exclusively relied. Between the years 1891 and 1902 a total of 1,280 animals was placed on Seward Peninsula in the general vicinity of Bering Straits and from this original stock have grown the present extensive herds with an estimated yield of 1 million animals. The industry is confined almost wholly to the tundra areas of the Territory and herds are now found in the coastal areas of Bering Sea and the Arctic Ocean from Kodiak Island and the Alaska Peninsula on the south to Point Barrow on the north. Tundra lands are peculiarly well suited to reindeer grazing owing to the presence of a suitable forage cover and the ease of herding. Also, the population of northwest and west Alaska is largely concentrated along the coast, and the industry has logically developed on the nearby range which is almost exclusively tundra.

The animals furnish a wide variety of products. The meat is used for food, the offal from butchering for dog feed, and the skins for winter clothing for local use as well as for fine leather. Reindeer are used to some extent in Alaska as a means of transportation, but seldom as milk animals.

Reindeer raising has become an established industry carried on by both Eskimos and whites. The number of animals has increased far beyond the local needs, and meat, hides, and other products are now sold in the general American markets.

The animals are raised on the open range and herded to prevent straying. They are grazed throughout the year and rely entirely on the range food supply. The practice in the industry is to confine each herd to a separate natural topographic unit which comprises both summer and winter range and has fawning grounds as well as buildings, corrals, and other necessary improvements.

The reindeer is closely related to the wild caribou and intermingling of the two classes of animals produces losses to the herd

owner in the straying away of reindeer with the caribou. Intermingling is also undesirable because the caribou as a game animal should be kept pure in strain. The coming of the reindeer industry thus requires the sacrifice of the caribou on the same range and this necessitates the elimination of caribou from the coastal areas of the Bering Sea and Arctic Ocean.

Examination of the range conditions in localities where reindeer grazing has been carried on for some years shows a great need for effective range management. In many cases great damage has been done to the cover, and range specialists state that from 15 to 40 or more years are required to bring back to depleted lands the lichens that are so important to the industry.

CATTLE AND SHEEP RAISING

The agricultural areas of the interior and the Cook Inlet localities, because of forage conditions as well as market demands, are better suited to dairying and to cattle raising as a feature of general farming than to large specialized stock-raising enterprises.

The grasslands of the Alaska Peninsula, Aleutian Islands, and Kodiak Island appear to be well suited to the raising of cattle and sheep on an extensive scale and eventually large sections of these lands will doubtless be brought into use by the livestock industry. Favorable features include the heavy forage cover, a long grazing season due to the relatively mild winter climate, and the possibility of harvesting the extensive stands of beach grasses and sedges for hay and silage. The attempts made to date to establish the industry here have not been very successful, owing in large part to inadequate transportation facilities for reaching the more populous parts of the Territory and the cities of the Pacific Northwest, but it is anticipated that this disadvantage will sometime be eliminated.

Important waterfowl and wild game sanctuaries are located in the grassland sections of the Territory. Grazing privileges may have to be withheld or specially restricted on some of these sanctuaries.

WILDLIFE

Alaska is rich in wildlife resources and is recognized as one of the outstanding game areas of the world for wilderness animals. The game contributes to the food supply and the furbearers to the cash income of isolated local inhabitants, but the greatest value of the wildlife to the Territory results from its being an attraction to hunters, naturalists, photographers, painters, tourists, and other visitors. The local economic benefits are not, however, the only reason for keeping the Territory well stocked. The general public of the United States, with a stake in the federally owned lands of Alaska, is interested in maintaining abundant wildlife resources as a recreational feature for public enjoyment.

After making a liberal allowance of lands for the further expansion of the reindeer, agricultural, and stock-raising industries there remains a vast area with a vegetative cover that can be utilized profitably for the support of a large and varied wildlife population. Also, lands to be used later for the industries mentioned above can provide support for wildlife until needed for these other purposes.

The notable big-game animals of the Territory include the group of huge bears known as the Alaska brown bear, various species of the grizzly bear group, the polar bears of the Arctic seas, moose, and white mountain sheep. Other valuable wild animals are caribou, black bear, glacier bear, mountain goat, Sitka blacktail deer, and rabbits. Breeding grounds for wild ducks, geese, and a multitude of other migratory birds are found on the shores of the Arctic Ocean and the Bering Sea. Upland game birds include ptarmigan and grouse. The fur-bearing animals include black, silver, gray, blue, and white foxes, the martin, beaver, otter, mink, ermine, muskrat, and wolverine.

The Alaska brown bears, of which the Kodiak bear is the largest individual species, are the largest carnivorous animals in the world. They occur on the islands and in the coastal sections of southern Alaska from southeastern Alaska to the Aleutian Archipelago, and have a range of not less than 100,000 square miles. The grizzly bears, close relatives of the Alaska brown bear, are found over most of the Territory. These two groups of bears are of outstanding interest to big game hunters and students of wildlife. They are fairly numerous and are thought to be increasing in numbers as the result of good enforcement in the past 15 years of the law against the sale of pelts. A careful estimate of the number of Alaska brown bears on Admiralty Island in southeastern Alaska, made in connection with the establishment of a bear-management plan for the island, showed a population of 900 on the island area of 1,664 square miles, or 1 animal to 1.85 square miles. The stocking on this island is doubtless somewhat heavier than on the range as a whole.

The moose closely follows the brown and grizzly bears in public interest. It occurs throughout most of the timbered section of the Territory. Kenai Peninsula, east of Cook Inlet, has the largest specimens of moose and an unusually heavy concentration of animals.

The white mountain sheep is found in large numbers along almost the full length of the Alaska Range, over great sections of the Brooks Range, and in parts of the Chugach and Kenai Mountains on the south coast. The steady increase in the number of rabbits in recent years has been beneficial to the sheep in that its natural enemies—wolf, coyote, and lynx—now have this alternate source of food.

The caribou is the most numerous of all Alaska big-game animals. Various estimates of the population of the five more or less distinct herds which are recognized are around 1 million. It is widely distributed throughout the high country of the interior plateau region, Alaska Range, and Brooks Range, and along the full length of the Alaska Peninsula. While the caribou is not highly prized by big-game hunters, its occurrence in vast numbers in the wilderness areas, its migrations, and other equally interesting features add greatly to the pleasure of visiting sportsmen and tourists. It constitutes an important source of food supply for the pioneer in the isolated sections of the Territory. The caribou, in fact, occupies a position in Alaska quite similar to that occupied by the bison in the Western States, and both sentiment and economic considerations dictate that it should be maintained in large numbers.

Black bears are found throughout most of Alaska, except in the treeless regions. Glacier bears are confined in the mountain system of the southern coast.

Mountain goats are found in the mountains of the southern coast eastward of Cook Inlet, and north to the Wrangell Mountains.

Deer, while abundant in southeastern Alaska, do not occur naturally on the main area of the Territory. Several years ago some small islands in Prince William Sound were successfully planted with deer, and good-sized herds are now found in that locality.

Snowshoe rabbits and Arctic hares abound in most sections of the Territory and are again on the increase. The rabbit population is subject to violent but regular fluctuations with the peak being reached about every ninth year. In the years of greatest concentration they often jeopardize the supply of browse required as winter feed by game animals, but, on the other hand, their increased number constitutes an enlarged food supply for most of fur bearers.

The fur bearers of the Territory are widely distributed and reports of game and fur wardens indicate that the number of animals is now on the increase. Such increase is probably due to lessened trapping during the business depression and to the present large rabbit population. By furnishing employment with a cash return to many local inhabitants both white and native, the fur bearers are an important economic resource for a pioneer country in which the opportunities for earning cash are restricted. Fur farming, especially the raising of foxes, has become an industry of some importance. The value of the furs shipped from Alaska from 1912 to 1934 was $39,600,000.

Migratory waterfowl breed in large numbers on the extensive tundra and marshlands, particularly of the Arctic Slope, Yukon Delta, Yukon Flats, islands of the Bering Sea, and the Aleutian Island chain. These nesting grounds contribute to the supply of birds using the Mississippi flyway along the main drainage of the Mississippi River, the central flyway of the high plains and Rocky Mountain region, and the Pacific flyway which leads directly down the Pacific coast.

Migratory waterfowl are in the front rank of wildlife resources and unfortunately the supply of birds over the vast interior section of the United States has become greatly depleted, owing to the destruction of breeding grounds as a result of the drainage of shallow lakes and marshes for agricultural use and the widespread drought conditions which prevailed in the 5 years following the 1929 nesting season. The nesting grounds of the northern and northwestern sections of Alaska have thus become of increasing importance in the maintenance and replenishment of the bird supply in these more southerly regions.

The nesting grounds of Alaska are excellent. They are well watered and possess the equally valuable feature of remoteness. The human population of the major wildfowl localities is small and there is little danger of any material increase in human encroachment in the near future. The only adverse feature of importance is the occurrence of wolves and coyotes which prey on the birds and eggs. Measures to control these predatory animals are badly needed.

Predatory Animals

The principal predators are coyotes and wolves. Wolves have long been troublesome, but only recently have coyotes become a serious problem in Alaska. Coyotes have been spreading to the northwest in North America for many years, and they first entered the Territory about 25 years ago, but as late as 1925 they were not an important factor in game losses. They are now very numerous and occur as far as Point Barrow to the northwest and Kenai Peninsula to the southwest. They are preying heavily on caribou, fur bearers, mountain sheep, upland birds, and on nesting waterfowl on the northwestern coast.

The Biological Survey carried on control activities in Alaska in the period 1927 to 1931, but terminated the work on the latter date because of lack of funds. A bounty is offered by the Territory on coyotes and wolves, but this control measure has not proved highly effective in reducing or even holding in check the number of these animals.

Fire

The outstanding menace to wildlife, reindeer grazing, stock raising, and agricultural development, except in the humid south coast region, is the depletion of the vegetative cover by fire. The effects of fire far transcend in importance the combined results of all other agencies which work toward the depletion of the valuable land resources of the Territory. The scant precipitation, the high proportion of daylight hours combined with warm weather in the summer months, and the occurrence of a continuous matlike ground cover of vegetation constitute a high fire hazard. Not uncommonly a fire will rage for many weeks and extend over hundreds of square miles before being checked by natural barriers such as rivers or by the coming of the fall rains.

In one specific instance noted, a fire that started in the spring was still burning in September. A fire in the Illiamna Lake region at the base of the Alaska Peninsula, which was reported in June 1935 by airplane pilots as constituting a menace to air travel due to the smoke, had then been burning for 2 weeks and had advanced 50 miles. In the same summer a fire in the Kvichak River section, burning for more than 2 months in brush, grass, tundra, and scrub timber, covered an area estimated at 1,000 square miles in a region formerly teeming with wildlife of every sort. Numerous fires, many of which have been burning unmolested for long periods, can be seen in the course of a trip during the summer months along any main route of travel.

The most accessible localities, such as those around settlements and along roads, trails, and navigable rivers, have suffered the greatest fire damage and exhibit extensive areas of continuous burn and large tracts that have been almost denuded as the result of repeated fires.

This devastation goes on year after year in almost every section of the Territory north of the Pacific coastal strip and has been a serious matter since 1900, at least. No satisfactory estimates can be made of the extent of the damage done to date, but it is safe to say that tens of millions of acres have been fire-swept at least once, and much of this area two or more times, in the past 35 years. As long ago as 1913 an interested observer estimated that fires had covered an average of

1 million acres a year in the preceding 20 years. The slow growth of much of the vegetation in this sub-Arctic region, especially lichens and the principal tree species, results in an exceedingly slow recovery of the burned-over areas.

Fires in Alaska are almost wholly man caused (lightning being a negligible factor) and are due in large measure to a lack of appreciation of their damaging effects on the vegetative cover and hence on the enterprises which this cover helps to support. Hunters, prospectors, wood cutters, and all classes of travelers leave behind them live camp fires and mosquito smudges which frequently lead to extensive burns. Fires used in land-clearing operations for cabin sites, homesteads, and placer mining are often set with no thought of preventing their spread to the surrounding wild lands. In fact, a majority of persons who travel, work, or live on the open range handle fire in a casual way that indicates a failure to realize that unrestrained burning is draining away a large share of the resources on which the Territory is dependent for its continued well-being. The past few years, however, have witnessed a considerable change of sentiment in this matter. Increasing visual evidence of the fire damage to resources, the objection of tourists to the smoke pall which obscures the scenery, and the interference of the smoke with airplane travel are all factors that work in that direction. The last-named is important, as air transportation is widely used in Alaska. It is believed that, with aggressive leadership, a predominant sentiment against fire could soon be obtained.

Federal Agencies in Charge of Land and Cover Resources

The Department of the Interior

The Department of the Interior administers practically all the lands of the main area of Alaska, the exceptions being the Chugach National Forest and a few areas of relatively small size. The Mount McKinley National Park and the Katmai National Monument are in charge of the National Park Service of this Department, but the great bulk of the lands have the status of open public domain and thus come under the supervision of the General Land Office. It is the open public domain that is subject to the high fire risk, is suffering the heavy losses, and has suffered such losses over a period of 35 years.

The fire-protection efforts of the Federal Government on the open public domain at this time are almost negligible. The General Land Office in recent years has been employing a few men temporarily during the fire season for protective work in the vicinity of some of the larger towns. The Government-owned Alaska Railroad takes steps to prevent and suppress operating fires along the right-of-way. Any additional measures taken are very limited in scope or restricted to small areas.

No serious attempt has ever been made to provide adequate fire protection on the open public domain of Alaska. Good results can be obtained only through the formulation and conscientious application year after year of a broad, well-considered plan of organ-

ization and operation. If such a plan had been initiated by the Federal Government for these Alaska lands between the years 1905 and 1910, when the national forests of the Western States were being brought under planned protection, and had the plan been carefully followed thereafter, the cover resources would still be almost intact on millions of acres that are now fire swept.

THE FOREST SERVICE, DEPARTMENT OF AGRICULTURE

The Forest Service administers the Chugach National Forest of 7,588 square miles on the southern coast of the main body of the Territory. Three-fourths of the forest has a light fire risk due to the humid climate. In the remaining portion, in a zone of fairly high risk, the Forest Service has maintained an efficient system of fire protection for the past 25 years.

BIOLOGICAL SURVEY AND ALASKA GAME COMMISSION

The Department of Agriculture, acting through the Biological Survey, has charge of the protection of game animals, land fur bearers, migratory waterfowl, and upland game birds. Its field of activity does not include the protection from fire of the cover on which this wildlife is dependent. In addition to regulatory work the Biological Survey makes scientific studies of wildlife and wildlife conditions, establishes game animals on empty ranges, carries on predatory animal control projects, and makes extensive scientific investigations of the reindeer industry and of fur ranching.

The local regulatory agency of the Biological Survey is the Alaska Game Commission, which was established in 1925. This Commission, the membership of which is appointed by the Secretary of Agriculture, consists of five men, one from each of the four judicial divisions of the Territory, and an executive officer who is the representative of the Biological Survey in Alaska. The Commission commonly meets once yearly. It proposes for action by the Biological Survey and the Secretary of Agriculture such regulations as seem advisable with respect to hunting seasons, bag limits, establishment of game and fur districts, and designation of lands as refuges. It formulates general plans for regulatory work to be carried out under the direct supervision of the executive secretary, and makes recommendations for action by the Biological Survey on such matters as predatory-animal control, the restocking of game lands, the introduction of new game species, and the study of wildlife problems.

The Territorial government has no responsibilities in connection with the protection of Alaska wildlife.

RECOMMENDATIONS FOR ACTION

Adequate management of the cover resources of Alaska lands will require the establishment and application of a program of varied and related activities. The following are the most important considerations: Protection from fire must be given the vegetative cover; better protection against predators must be extended to the wildlife resources and domestic range animals; specific areas should be dedi-

cated to the specific types of use for which they are best fitted; suitable restrictions should be placed on the use of resources on lands which are not to be patented; scientific studies are needed of problems affecting the resources and their dependent industries.

Fortunately the demands of the existing situation in Alaska can be met quite satisfactorily by the comparatively simple measures hereinafter proposed.

SURVEY OF THE PLANT COVER

A comprehensive study of the cover resources of the lands of the open public domain is needed as a basis for providing the various resources and their dependent activities with integrated systematic plans for protection and management.

In connection with this study the vegetative-cover types of the open public domain should be mapped on broad lines. The cover conditions and especially the extent and degree of fire damage on many large areas are little known. The mapping project should cover first those localities of primary interest in connection with the establishment of plans for a fire-protection system, controlled grazing, predatory animal control, and game management. The field data can be obtained most quickly and at least expense by means of aerial photographic surveys.

An early start on the protection and land-planning program is so desirable that in case delay is encountered in the general mapping project, the program should be initiated on the basis of cover data now available, or readily obtainable by the usual reconnaissance methods.

The suggested aerial photographic survey of vegetative cover might well be combined with a similar survey of topography for the use of other branches of the Government and particularly the United States Geological Survey. Through such an arrangement the cost of the work to the agency especially concerned with the vegetative cover should not exceed $50,000 per year for a period of 5 years.

FIRE PROTECTION ON THE OPEN PUBLIC DOMAIN

The establishment of a fire-protection organization on the open public domain is an essential first step in any attempt to bring the public-land resources under a reasonable degree of control. The executive head of the project should be sympathetic with its objectives and experienced in the broad aspects of administrative work in fire protection. The organization should be represented in each of the larger community centers throughout the regions of high fire risk, but the initial forces of each headquarters might well be limited to the key men around whom a larger field force is later to be built, and one or two assistants. Most of these men should be yearlong employees. The key men should be of proven ability in establishing fire-protection systems, including ability to promote favorable public sentiment, and effect cooperative agreements with public and private agencies for the prevention and suppression of fires.

Educational efforts directed toward fire prevention would constitute one of the major functions of the organization and be especially

important during the first few years. With a population in the fire-susceptible regions of not to exceed 32,000 or the equivalent of one person to 16 square miles, an opportunity exists for highly effective educational work through frequent personal contact. Close association should be maintained with miners, mining companies, transportation agencies such as air transport, river steamer, and stage lines, sportsmen's organizations, and, in fact, all classes of workers and agencies having activities in the open country.

Cooperation in the prevention, reporting, and suppression of fires should be arranged among the many Federal and Territorial agencies having widespread representation throughout the country, such as the Alaska Road Commission, Alaska Game Commission, Alaska Railroad, and Bureau of Indian Affairs. The cooperating public agencies will, as a whole, be able to carry a large part of the burden of fire-protection work if given competent direction and some financial assistance by the fire organization.

During the initial stages of the fire-protection administration the keymen should make a detailed study of the fire conditions of their respective districts. The fire organization should not be materially expanded or incur the expenditure of large sums for detection and suppression equipment until these studies and the experience of the keymen have indicated the size and character of the fire problem and how it can best be met. On the basis that the keymen and their principal assistants would be employed throughout the year, the cost of the work during the first 3 or 4 years should not exceed $60,000 per year.

REINDEER GRAZING

A study should be made of the range needs of the reindeer industry, following which the industry should be allotted a definite portion of the open public domain. Reindeer grazing should be restricted to this allotment. This action will effect a segregation of reindeer and caribou and thus protect the purity of the strain as well as the food supply of both classes of animals. Both reindeer and caribou are highly important in the economy of Alaska, and each is entitled to an equitable share of the range lands of the Territory. The reindeer allotment area should be based on the location and size of the present industry, the possibilities for expansion, and the need for a combination of range features for each herd. Interested public agencies have considered this problem and tentatively selected an area embracing approximately 100,000 square miles in the form of a wide strip along the coasts of Bering Sea and the Arctic Ocean.

Within the reindeer area, plans for range management should be perfected which will provide for the proper use and protection of the range resources, including the recovery of those lands which have already suffered from overgrazing. Definite grazing areas should be allotted each herd.

This activity will require a small permanent supervisory force composed of men of training and experience in grazing-land administration. The cost will be approximately $50,000 per year.

DETERMINATION OF AGRICULTURAL AREAS

The localities of highest agricultural value on the open public domain should be determined with proper weight being given to all of the factors involved, including accessibility and available markets. While homestead entry should not be restricted to these localities, their advantages should be pointed out to prospective farmers. Action along the above lines should tend to concentrate agricultural settlement on the better areas, with resultant economic and social benefits. Such classification work will need the cooperation of the agricultural division of the Alaska University at Fairbanks.

The sum of $25,000 per year for a period of 5 years should be made available for this project.

PREDATORY ANIMAL CONTROL

A permanent program of intensive predatory animal control, with special reference to coyotes and wolves, should be put into effect at once. The distribution of coyotes throughout most of the Territory, including the isolated breeding grounds of waterfowl on the shores of the Bering Sea and Arctic Ocean, will necessitate widespread control work. A permanent force of well-trained men should be built up for this work as rapidly as possible. An allotment of not less than $50,000 per year will be needed to start the activity.

GAME-MANAGEMENT AREAS

For the purpose of having wildlife contribute more fully to the economy of the Territory, lands of outstanding value for the more desirable species of game animals should be officially designated as "managed hunting grounds" or "game-management areas", and a game-management plan should be provided for each of such areas. The plan should afford special and intensive treatment to the area and its game with the object in view of maintaining a numerous game population and improving the hunting conditions. The work will call for close cooperation between the Federal agency having supervision of the cover resources of the open public domain or other publicly owned lands involved, and the Alaska Game Commission. Satisfactory game management will involve an expenditure of not less than $75,000 per year.

WILDLIFE REFUGES

An intensive study should be made of the possible need for additional wildlife refuges and for adjusting the boundaries of existing refuges. It may be found that the best results can be obtained by the use of numerous relatively small refuges rather than a few large ones, or by supplementing the existing large refuges with additional small ones. A study of the refuge situation with respect to the big brown and grizzly bears is especially desirable at this time.

EXPERIMENT STATION

There are many problems connected with the growth, protection, and utilization of the forest and range resources which require the intensive, systematic, and persistent study which can be best provided by an experiment station. A forest and range experiment station similar to those maintained by the Department of Agriculture in continental United States should be established in Alaska. The headquarters station should doubtless be located at Juneau in southeastern Alaska and branches would be needed in interior Alaska, the tundra region of the northwest coast, and the grassland areas of the Alaska Peninsula and Kodiak Island.

The operation of the station and its branches will involve expenditures totaling $100,000 per year. In addition, buildings and other station improvements will cost $95,000 yearly for the first 5 years.

INTEGRATED ADMINISTRATION

The administration of the cover resources of the open public domain of Alaska should be based on an integrated program of Federal activity, under which fire protection and the conditions or restrictions to be set up to assure proper use, will be brought into harmony with the varying requirements of wildlife, reindeer, cattle, and sheep, and other interests which are dependent on the cover for existence. A satisfactory program will be difficult to establish and carry out under the present system of Federal administration, which places responsibility for fire protection and use of the cover in the Department of the Interior while giving the Department of Agriculture the responsibility for studying the cover requirements and promoting the welfare of the above-mentioned interests. Different viewpoints of the two Departments with respect to the things necessary or desirable to be done or the degree of stress to be given each of several activities would doubtless result frequently in no action being taken, or at least in delays. For example, studies by the Biological Survey, Department of Agriculture, of the best methods to employ in reindeer grazing to avoid or check depletion of the range vegetation can be of little value if the facts determined are not used as a basis for restrictions in the use of the range by herd owners.

A more satisfactory accomplishment would be possible if the administration of the forest, tundra, and grass resources of the open public domain were transferred to the Department of Agriculture. This Department has a greater official interest in the protection and proper management of resources of this type than any other Federal agency and the problems involved in Alaska are of the same general character as those which receive the attention of the organization and personnel of this Department throughout the United States.

RANGE TYPES

The 10 range types listed in chapter II, into which, for simplification of treatment, the enormously complex vegetation of the western range country has been broken down, are separable further into distinct subtypes. These types and subtypes, listed below, are based largely on the treatment of Shantz and Zon as shown in the Atlas of American Agriculture, Part I, the Physical Basis of Agriculture: Section E, Natural Vegetation (U. S. Dept. Agr. 1924). This has been modified by subsequent observations of the Forest Service and of other organizations and individuals who have made special studies of the subject.

TALL GRASS

"Big bluestem" sod.
Porcupine grass—slender wheatgrass.
"Little bluestem" bunchgrass.

SHORT GRASS

Blue grama.
Blue grama—buffalo grass.
Bluestem ("western wheatgrass").
Galleta.
Red three-awn ("wiregrass").
Blue grama—needle-and-thread ("western needlegrass").

PACIFIC BUNCHGRASS

Bluebunch wheatgrass sod.
California needlegrass—Sandberg bluegrass.
Bluebunch wheatgrass bunchgrass.

SEMIDESERT GRASS

Mesquite grass (desert grassland).
Mesquite and desert-grass (desert savanna).

SAGEBRUSH-GRASS

Sagebrush associated with numerous grasses.

SOUTHERN DESERT SHRUB

Creosotebush.
Yucca-cactus.
Saltbush.
Mesquite.

SALT-DESERT SHRUB

Black sagebrush.
Shadscale.
Hop-sage.
Gray molly ("white sage").
Little rabbitbrush.
Winterfat.
Bud sagebrush ("budsage").
Greasewood.

PIÑON-JUNIPER

Coniferous woodland.

WOODLAND-CHAPARRAL

Oak-grass.
Chaparral.
Dense woodland.
Chamise.

OPEN FOREST

Ponderosa pine—Douglas fir.
Aspen-fir.
Alpine grassland.
Ponderosa pine—sugar pine.
Mountain brush.
Spruce-fir (Rockies and Intermountain).

RANGE SPECIES REFERRED TO IN THE REPORT

The following list gives the common names of range species referred to in previous pages together with the appropriate botanical name. Common names that are not accepted, but are locally familiar, are indicated by quotation marks.

Acacia	Acacia sp.
Agave	Agave sp.
Alfalfa	Medicago sativa.
Alkali sacaton	Sporobolus airoides.
Alpine bluegrass	Poa alpina.
Alpine timothy	Phleum alpinum.
American sloughgrass	Beckmannia syzigachne.
Anemone	Anemone sp.
Aster, wreath	Aster multiflorus.
Balsamroot	Balsamorhiza sp.
Beardgrass ("broomsedge")	Andropogon sp.
Beardgrass, prairie	A. scoparius.
"Beggartick" (western stickseed)	Lappula occidentalis.
Big sagebrush	Artemisia tridentata.
Bitterbrush	Purshia tridentata.
Bitter rubberweed ("bitterweed")	Actinea odorata.
Black grama	Boutelous eriopoda.
Black medic	Medicago lupulina.
Black sagebrush	Artemisia nova.
Bluebells	Mertensia sp.
"Bluebunch fescue" (Idaho f.)	Festuca idahoensis.
Bluebunch wheatgrass	Agropyron spicatum.
Blue grama	Bouteloua gracilis.
Bluegrass	Poa sp.
Bluegrass, alpine	P. alpina.
Bluegrass, Kentucky	P. pratensis.
Bluegrass, Sandberg	P. secunda.
Bluejoint turkeyfoot ("big bluestem")	Andropogon furcatus.
Bluestem ("western wheatgrass")	Agropyron smithii.
"Bluestem, big" (bluejoint turkeyfoot)	Andropogon furcatus.
"Bluestem, little" (prairie beardgrass)	Andropogon scoparius.
Brome (bromegrass)	Bromus sp.
Brome, mountain	B. carinatus.
Brome, smooth	B. inermis.
Broomweed	Amphiachyris dracunculoides.
"Broomsedge" (beardgrass)	Andropogon sp.
Bud sagebrush ("bud sage")	Artemisia spinescens.
Buffalo grass	Buchloë dactyloides.
Bur-clover, California	Medicago hispida.
Burrograss	Scleropogon brevifolius.
Burroweed	Aplopappus fruticosus.
"Burroweed" (jimmyweed)	A. heterophyllus.
"Burroweed" (white bur-sage)	Franseria dumosa.
Bush morning-glory	Ipomoea leptophylla.
Butterflyweed ("pleurisy-root")	Asclepias tuberosa.
California bur-clover	Medicago hispida.
California needlegrass	Stipa pulchra.
California oatgrass	Danthonia californica.
Cane, small ("switch c.")	Arundinaria tecta.
Cane, southern ("giant c.")	A. gigantea.
Carolina clover	Trifolium carolinianum.
Catclaw	Acacia greggii.
Ceanothus	Ceanothus sp.
Centuryplant	Agave americana.
Chamise	Adenostoma fasciculatu
"Cheatgrass" (downy chess)	Bromus tectorum.
Chess, downy	Do.
Chess, foxtail	B. rubens.

Cliffrose	Cowania stansburiana.
Clover	Trifolium sp.
Clover, Carolina	T. carolinianum.
Clover, crimson	T. incarnatum.
Clover, white	T. repens.
"Coffeeberry" (jojoba)	Simmondsia californica.
Common lespedeza	Lespedeza striata.
Creosotebush	Covillea tridentata.
Crested wheatgrass	Agropyron cristatum.
Crimson clover	Trifolium incarnatum.
"Crowfoot grama" (Rothrock g.)	Bouteloua rothrockii.
Curly-mesquite	Hilaria belangeri.
Deathcamas	Zygadenus sp.
Downy chess ("cheatgrass")	Bromus tectorum.
Dropseed, pine	Blepharoneuron tricholepis.
Dropseed, sand	Sporobolus cryptandrus.
Drymaria	Drymaria holosteoides.
Elk sedge ("elkgrass")	Carex geyeri.
False-hellebore	Veratrum sp.
Fanscale saltbush	Atriplex polycarpa.
Fescue, Idaho ("bluebunch f.")	Festuca idahoensis.
Fescue, sheep	F. ovina.
Fescue, sixweeks	F. octoflora.
Firewood	Chamaesaracha angustifolium.
"Fleabane" (wild-daisy)	Erigeron sp.
Fluffgrass	Triodia pulchella.
Foxtail chess	Bromus rubens.
"Gallberry" (Inkberry)	Ilex glabra.
Galleta	Hilaria jamesii.
Geranium	Geranium sp.
"Giant cane" (southern cane)	Arundinaria gigantea.
Giant wild-rye	Elymus condensatus.
Goldenrod	Solidago sp.
Grama	Bouteloua sp.
Grama, black	B. eriopoda.
Grama, blue	B. gracilis.
Grama, Rothrock ("crowfoot g.")	B. rothrockii.
Grama, side-oats	B. curtipendula.
Gray molly	Kochia vestita.
Greasewood	Sarcobatus vermiculatus.
Hackberry	Celtis sp.
Hawksbeard	Crepis sp.
Hairgrass, tufted	Deschampsia caespitosa.
Highland live oak	Quercus wislizenii.
Hop-sage	Grayia sp.
Horsebrush	Tetradymia sp.
Idaho fescue ("bluebunch fescue")	Festuca idahoensis.
Indian grass	Sorghastrum nutans.
Indian ricegrass	Oryzopsis hymenoides.
Inkberry ("gallberry")	Ilex glabra.
Jimmyweed ("burroweed")	Aplopappus heterophyllus.
Jojoba ("coffeeberry")	Simmondsia californica.
Junegrass	Koeleria cristata.
Kentucky bluegrass	Poa pratensis.
Knotweed	Polygonum sp.
"Klamath weed" (St. Johnswort)	Hypericum perforatum.
Larkspur (also low l. or tall l.)	Delphinium sp.
Leadplant ("shoestrings")	Amorpha canescens.
Lespedeza, common	Lespedeza striata.
"Little bluestem" (prairie beardgrass)	Andropogon scoparius.
Little rabbitbrush	Chrysothamnus stenophyllus.
Loco	Astragalus sp.
Lovegrass	Eragrostis sp.
Low larkspur	Delphinium sp.
Lupine	Lupinus sp.
Maidencane ("Paille firme grass")	Panicum hemitomon.
Manzanita	Arctostaphylos sp.

Medic, black	Medicago lupulina.
Melic; onionsgrass	Melica sp.
Mesquite	Prosopis sp.
Milkvetch	Astragalus sp.
Mimosa	Mimosa sp.
Molly, gray	Kochia vestita.
Morning-glory, bush	Ipomoea leptophylla.
Mountain brome	Bromus carinatus.
Mountain-dandelion	Agoseris sp.
Mountain-mahogany	Cercocarpus sp.
Muhly, ring	Muhlenbergia torreyi.
Needle-and-thread ("western needlegrass")	Stipa comata.
Needlegrass	Stipa sp.
Needlegrass, California	S. pulchra.
Needlegrass, western	S. occidentalis.
"Needlegrass, western" (needle-and-thread)	S. comata.
Oatgrass, California	Danthonia californica.
Oat, slender	Avena barbata.
Ocotillo	Fouquieria splendens.
Onionsgrass; melic	Melica sp.
"Paille firme grass" (maidencane)	Panicum hemitomon.
Paloverde	Cercidium sp.
Panicgrass	Panicum sp.
"Panicgrass, tall" (switchgrass)	P. virgatum.
Peavine	Lathyrus sp.
Pennyroyal, rough	Hedeoma hispida.
Phlox	Phlox sp.
Pickleweed	Allenrolfea occidentalis.
Pine dropseed	Blepharoneuron tricholepis.
Pinegrass	Calamagrostis rubescens.
"Plains plantain" (woolly Indianwheat)	Plantago purshii.
"Pleurisy-root" (butterflyweed)	Asclepias tuberosa.
Poison-oak	Toxicodendron sp.
Pacific poison-oak	T. diversilobum.
Popples	(Used inclusively for several related genera.)
California-poppy	Eschscholtzia sp.
Poppy	Papaver sp.
Desertpoppy	Arctomecon sp.
Matilija-poppy	Romneya sp.
Tree poppy	Dendromecon sp.
Porcupine grass	Stipa spartea.
Prairie beardgrass ("little bluestem")	Andropogon scoparius.
Prairie sandgrass	Calamovilfa longifolia.
Prickly pear	Opuntia sp. (flat-jointed spp.).
Rabbitbrush	Chrysothamnus sp.
Rabbitbrush, little	C. stenophyllus.
Red three-awn ("wiregrass")	Aristida longiseta.
Redtop	Agrostis sp.
Ricegrass, Indian	Oryzopsis hymenoides.
Ring muhly	Muhlenbergia torreyi.
Ripgut grass	Bromus rigidus.
Rothrock grama ("crowfoot grama")	Bouteloua rothrockii.
Rough pennyroyal	Hedeoma hispida.
Russian-thistle	Salsola pestifer.
Sacaton	Sporobolus wrightii.
Sacaton, alkali	S. airoides.
Sagebrush	Artemisia sp.
Sagebrush, big	A. tridentata.
Sagebrush, black	A. nova.
Sagebrush, bud ("bud sage")	A. spinescens.
Sagebrush, sand	A. filifolia.
Slickseed grasses	Paspalum spp.
Saltbush	Atriplex sp.
Saltbush, fanscale	A. polycarpa.
Saltgrass	Distichlis sp.

Sandberg bluegrass	Poa secunda.
Sand dropseed	Sporobolus cryptandrus.
Sandgrass, prairie	Calamovilfa longifolia.
Sand sagebrush	Artemisia filifolia.
Seepweed	Dondia sp.
Shadescale	Atriplex confertifolia.
Sheep fescue	Festuca ovina.
"Shoestrings" (leadplant)	Amorpha canescens.
Side-oats grama	Bouteloua curtipendula.
Sixweeks fescue	Festuca octoflora.
Skunkbush	Rhus trilobata.
Sleepy grass	Stipa robusta.
Slender oat	Avena barbata.
Slender wheatgrass	Agropyron pauciflorum.
Sloughgrass, American	Beckmannia syzigachne.
Small cane ("switch cane")	Arundinaria tecta.
Snakeweed	Gutierrezia sarothrae.
Sneezeweed	Helenium hoopesii.
Snowberry	Symphoricarpos sp.
Snowbrush	Ceanothus velutinus.
Soaptree	Yucca elata.
"Soapweed" (yucca)	Yucca sp.
"Spanish-bayonet" (yucca)	Do.
Southern cane ("giant cane")	Arundinaria gigantea.
Squirreltail	Sitanion hystrix.
St. Johnswort ("Klamath weed")	Hypericum perforatum.
Sunflower	Helianthus sp.
"Switch cane" (small cane)	Arundinaria tecta.
Switchgrass ("tall prairie grass"; "tall panicgrass").	Panicum virgatum.
Tall larkspur	Delphinium sp.
Tall panicgrass (or t. prairie grass)	Panicum virgatum.
Tarbush	Flourensia cernua.
Three-awn ("wiregrass")	Aristida sp.
Three-awn, red	A. longiseta.
Timothy, alpine	Phleum alpinum.
Timothy	Phleum pratense.
Toboosa	Hilaria mutica.
Tufted hairgrass	Deschampsia caespitosa.
Turkeyfoot, bluejoint	Andropogon furcatus.
Vetch	Vicia sp.
Waterhemlock	Cicuta sp.
Western needlegrass	Stipa occidentalis.
"Western needlegrass" (needle-and-thread)	S. comata.
Western stickseed ("beggartick")	Lappula occidentalis.
"Western wheatgrass" (bluestem)	Agropyron smithii.
Western yarrow	Achillea lanulosa.
Wheatgrass	Agropyron sp.
Wheatgrass, bluebunch	A. spicatum.
Wheatgrass, crested	A. cristatum.
Wheatgrass, slender	A. pauciflorum.
"Wheatgrass, western" (bluestem)	A. smithii.
White bur-sage ("burroweed")	Franseria dumosa.
"White sage" (winterfat)	Eurotia lanata.
White clover	Trifolium repens.
Wild-daisy ("fleabane")	Erigeron sp.
Wild-rye	Elymus sp.
Wild-rye, giant	E. condensatus.
Winterfat ("white-sage")	Eurotia lanata.
"Wiregrass" (three-awn)	Aristida sp.
Woolly Indianwheat ("plains plantain")	Plantago purshii.
Wreath aster	Aster multiflorus.
Yarrow, western	Achillea lanulosa.
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